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THE
BRITISH JOURNAL OF PSYCHOLOGY
MONOGRAPH SUPPLEMENTS

VII

QUICKNESS & INTELLIGENCE

AN ENQUIRY CONCERNING THE EXISTENCE OF
A GENERAL SPEED FACTOR

BY

E. BERNSTEIN, B.A., B.Sc., Ph.D.



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QUICKNESS AND INTELLIGENCE

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Education

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E. BERNSTEIN, B.A., B.Sc., PH.D.

CAMBRIDGE
AT THE UNIVERSITY PRESS
1924

PRINTED
BY THE
MUNIZ
PRESS

PRINTED IN GREAT BRITAIN

371.26
B 454g

PREFACE

THE research described in this monograph was carried out in the Central Department of the Jews' Free School, London, in the years 1919–1921. During the course of this comparatively long period I have been under obligation to many friends for help and advice, and I gladly avail myself of the opportunity afforded by publication to express my gratitude. I desire to record my thanks to the authorities of the Jews' Free School and to the Education Aid Society for assistance given in the prosecution of the research; to my colleagues of the Jews' Free Central School for their invaluable help and their ready response to the many calls made upon them; to the boys of the First Year Industrial, 1920–1921 Class, for the help they so willingly gave at a critical period in the research; to the New Wing Society to whose wonderful record of good deeds done must be added many kindly and helpful acts performed to myself in trying and difficult times; to my sister, Miss G. Bernstein, and to my nephew, Mr C. Freeman, for their invaluable help in the mechanical labour of preparing the many thousands of test sheets used in the work; to my colleague and friend Mr J. Power for reading the proof-sheets; to my friends Messrs Jack Rose, J. F. Sager and S. Newman, M.A., B.Sc., for their sacrifice of precious hours of a summer holiday in helping to meet a sudden demand for further tests; to my friend Mr John Lever, M.C., B.Sc., whose valuable assistance with the historical portion of the monograph was the chief benefit of our stay at Mawgan; and above all to Prof. Spearman, Director of the Psychological Laboratory, University College, London, under whose guidance the research has been conducted, and whose constant advice

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PREFACE

and never-failing sympathy provided at once a stimulus and a sustaining force throughout the course of the work. I wish to express my thanks to all who have helped in the publication of the monograph, and in this connection I desire to record a grant made by the University of London from its Publication Fund. Finally, with regard to the tests themselves, I should like to say that only a few sample sheets are given in this monograph. The tests applied to the subjects occupy a volume of over two hundred pages. The printing of this large number of tests was undertaken by my friend, Mr D. Fisherton, and carried out as it was under the most trying conditions of both time and labour constituted a fine act of friendship which will always remain a happy memory with me.

E. B.

January, 1924

CONTENTS

	PAGE
I. INTRODUCTORY:	
A. GROUP FACTORS	1
B. A GROUP FACTOR OF SPEED:	
1. A SPEED FACTOR IN PSYCHOLOGY	3
2. VIEWS ON SPEED ABILITY	3
C. PRACTICAL IMPORTANCE OF SPEED ABILITY QUESTION: OBJECTIONS TO TESTS	3
D. THE ENQUIRY: PROBLEMS CONSIDERED:	
1. IS THERE A SPEED ABILITY?	4
2. SHORT TESTS <i>v.</i> LONG TESTS—WHICH MORE DESIRABLE IN PRACTICE?	4
3. HOW DOES PRACTICE AFFECT CORRELATIONS?	4
II. PERSEVERATION:	
A. CONCEPT	5
B. PREVIOUS WORK:	
i. BEFORE LANKES	5
ii. LANKES	7
C. OWN TESTS:	
a. THE TESTS:	
1. DESCRIPTION OF PERSEVERATION TESTS EMPLOYED . .	8
2. RESULTS:	
i. Correlations	14
ii. Reliability of the Tests	16
b. ESTIMATE OF PERSEVERATION:	
i. Sources	16
ii. Reliability of Estimates of Perseveration	17
iii. Correlations between Tests and Estimates	18
III. THE MAIN ENQUIRY:	
A. PRELIMINARY CLASS OBSERVATIONS	19
B. THE TESTS:	
a. Tests <i>v.</i> Observation	22
b. Principle of the Method: 'Leisure' and 'Haste' Tests . .	23
c. Detailed Description of the Tests	23
d. Arrangement of the Tests: 'Ordered' and 'Mixed' Series .	30
e. Application of the Tests	31
f. Trial Tests	32
g. System of Marking	34
h. The Subjects	35

CONTENTS

	PAGE
C. ESTIMATE OF 'SLOWNESS' AND OF INTELLIGENCE:	
i. 'Slowness'	35
ii. Intelligence	37
D. RESULTS:	
a. TREATMENT:	
a. Tabulation	37
b. Basic and Derived Correlation Coefficients	37
b. CONSIDERATION OF RESULTS:	
(A)	
1. Reliability of the Tests	42
2. Reliability of the Estimates	44
(B) CORRELATIONS: 'DERIVED' COEFFICIENTS:	
1. Correlations with $Y + X$	45
2. 'Leisure' and 'Haste' Tests	46
3. Correlations with $L - H$	49
4. Correlations with $Y - X$	52
5. The Effect of Practice	53
c. GENERAL RESULTS	54

QUICKNESS AND INTELLIGENCE¹

I. INTRODUCTORY.

A. GROUP FACTORS.

THE present enquiry is concerned with the possible existence of a 'speed' factor operating independently of the factor of general ability '*g*.' Such a factor would be akin to 'group' factors which have been much quoted in recent literature. According to Spearman's Theory of Two Factors, in every intellectual performance two factors are operative—a general factor which enters, in varying degree, into all intellectual performances, and a second factor specific to the performance in question. The second factor may also be wider in range and enter into a number of intellectual performances, when it becomes a 'group' factor. The importance of this theory to psychology is its fundamental conception of a general common factor in the mental activity of an individual. The strength of this factor determines for any individual his position on a scale of intelligence; the strength of other factors—specific or group—determines his special abilities or disabilities. It may easily happen that a person of high general ability is exceedingly weak in some specific capacity—as pitch discrimination, etc. The volume of evidence which has been adduced in support of the theory since its formulation in 1904 is probably without parallel in the history of psychology. Although mental tests usually manifest, besides the general factor, only very specific ones indeed, at least one exception made its appearance from the very beginning. Krüger and Spearman found indications of a factor which was not the general one, but which nevertheless had a very considerable breadth. This factor is described by them as one entering into a group of abilities² and therefore constitutes what has been recently called a 'group factor.' This result was subsequently corroborated by several investigators. Thus, Hart and Spearman make the following statement in their paper on "General Ability"³: "Again the narrowness of range of specific abilities may not obtain universally: *there may be important exceptions*. For instance, the specific correlation discovered by Burt

¹ A thesis presented for the degree of Doctor of Philosophy in the University of London.

² Krüger und Spearman, "Die Korrelation zwischen verschiedenen geistigen Leistungsfähigkeiten," *Z. für Psychologie*, **44**, p. 103.

³ *Brit. Journ. of Psychology*, **5**, p. 75.

between school-work and tests of memory looks as if here the range might cover *all the diverse activities coming under the head of memorisation*. This deduction is corroborated by having already been reached on quite different and exclusively experimental grounds¹." Abelson also found evidence of the existence of a group memory factor, but his results have not yet been published. Carey² arrived at the conclusion "that there appears to be a very small general memory factor." Recently, T. Verner Moore, after applying the methods of Hart and Spearman in an investigation on the relation between memory and perception among abnormal subjects, came to the conclusion that there exists a group memory factor. Two group factors were actually found: "one factor is whatever special ability is involved in immediate memory, and the other is the special ability involved in the memory ratio—this latter would be something which might be called the power of retention³."

It will be observed that the existence of a 'group' memory factor has been established on the basis of ordinary mental tests employed in the investigations previously referred to. This result from ordinary mental tests by no means precludes the possibility of other group factors being discovered under special conditions. This was in fact done by Carey, who carried out a systematic investigation of 'specific' and 'group' factors and found that a number of the school subjects tested (needle-work, painting and writing) were influenced by a motor factor. Another group factor, that of 'perseveration,' had been suggested for some time by Müller, Wiersma and Heymans; its existence was corroborated, and its nature very completely investigated by Lankes. A third group factor has been discovered by Flügel under the name of 'oscillation'⁴. Webb, in his investigation of character, established the existence of a factor of wide generality, termed by him 'persistence of motives.' His results were subsequently submitted to further treatment by Garnett, who was able to identify another group factor, 'cleverness,' Webb's original factor being re-named by him as 'purpose.'

On the other hand, certain 'group factors' that had long been asserted to exist, were found to possess no such validity. One such negative result was found by Carey in respect of sensory discrimination⁵. Another striking negative result was that of McQueen in connection with 'span of attention.'

¹ The reference is to Krüger and Spearman's work noted above.

² *Brit. Journ. of Psychology*, **8**, p. 91.

³ T. Verner Moore, *Psych. Review*, Mon. Supp. **27**, p. 34.

⁴ *Proceedings of the Brit. Psych. Society*, May, 1915.

⁵ *Brit. Journ. of Psychology*, **8**, p. 91.

B. A GROUP FACTOR OF SPEED.

1. The possibility of the existence of a further group factor, that of speed, has hitherto received very little investigation in psychology. Indeed the only direct attempt to deal with the problem was that made by Hart and Spearman¹ in the course of their work on dementia. Of the large number of tests applied by them, very few showed any 'specific' correlation between the tests. The average specific correlation between the speed tests (addition, crossing out rings, cancellation, geometrical figures) was -0.09 , a result which points to the absence of a speed factor. This conclusion received support in the work of Jones² on the influence of age and practice on correlations: no specific correlations were determined but all the speed tests employed showed low correlation with one another.

2. While no definite pronouncement on the question of the existence of a speed ability can be made on the basis of the results hitherto obtained, belief in the existence of this ability is fairly widespread popularly. It is commonly assumed, for instance, that a person who is quick in some one mental process will show a similar quickness in other mental processes. In the same way a person may exhibit an all-round slowness—quite apart from the degree of intelligence he may possess—so that it is quite possible for a slow person to produce eventually as good a result as one who is quick, as is exemplified in such a description as "slow but sure." On the other hand, the altogether contrary view which identifies speed with intelligence is equally prevalent; to be quick is to be intelligent while slowness is synonymous with dullness. An illustration of this view is offered by Pearson's Scale of Ability in which 'Slow' is one of the five grades of intelligence employed.

C. PRACTICAL IMPORTANCE: OBJECTIONS TO TESTS.

Very important practical issues are raised by the question of a speed ability. The objection is being repeatedly offered that mental tests are tests of speed rather than of ability. Some force is given to this objection by the current tendency to apply a large number of tests in a short time. It is contended by such critics that the subjects who do well in these tests are certainly the fastest but by no means the best of those tested. The objection is in fact a challenge to the claim of intelligence tests to their very title, and cannot easily be ignored in view of the almost daily

¹ Hart and Spearman, "Mental Tests of Dementia," *Journ. of Abnormal Psych.* Oct.—Nov. 1914.

² E. S. Jones, "Influence of Age and Experience on Correlations concerned in the mental tests," *Educ. Psych. Mon.* No. 22.

extension of the application of tests for a variety of professional purposes. It may be noted that the objection tacitly assumes the possibility of the complete independence of speed and intelligence, and can be adequately dealt with only on the basis of an investigation of the problem of the existence of a speed ability.

D. THE ENQUIRY: PROBLEMS CONSIDERED.

1. The object of the present enquiry is to examine the validity of the conflicting views that are entertained on the relation of speed to intelligence—(1) the view based on the belief in the possibility of a speed ability, (2) the view that regards speed as identifiable with intelligence. The obverse aspect of 'slowness' was given greater prominence than quickness in the enquiry, as it provided a more favourable approach to the problem under the conditions in which the enquiry was carried out. Regarding the problem from the point of view of slowness, one may assign a subject's slowness to some definite cause like perseveration, defective conation, etc. Is there a 'slowness' apart from such traceable causes—a 'pure slowness'? Is there a speed ability, independent of general ability, so that a subject may be slow, and yet intelligent, or quick and yet dull?

2. Allied to the question as to whether speed or ability is the quality brought into play by tests, is the question of the lengths of the tests employed. Is the short test applied in large number, or the longer and more elaborate test, the more desirable in practice? This question was also brought within the scope of the enquiry.

3. Finally, the method employed made it possible to consider the question of 'coaching.' The question of 'coaching' has been frequently advanced as an objection against tests. If 'coaching' is really effective, then the application, on a large scale, of standardised tests, is rendered valueless; further the necessity imposed on examiners to employ new material and to invent new forms of tests, in order to circumvent 'coaching,' must result in the burden being increased so as to become eventually unbearable.

Before proceeding to describe the main enquiry, an account will first be given of previous work done on 'perseveration' in view of the importance of this trait as a factor, or even the main factor, in slowness.

II. PERSEVERATION.

A. CONCEPT.

Müller and Pilzecker¹, in introducing the term ‘perseveration tendency’ from pathology to normal psychology, used the term to denote “the tendency of ideas, after once having entered consciousness, to rise freely again into consciousness.” This spontaneous recurrence of experiences—spontaneous in the sense that the recurrence takes place without any discernible mediation of association—is a familiar phenomenon. The ‘running of a tune through the head,’ the continual (non-voluntary) repetition of a nonsense rhyme, the tendency of an accident or other painful scene that one has witnessed to recur in consciousness, are examples of the phenomenon. Since the introduction of the term by Müller and Pilzecker, the concept of perseveration has figured prominently in work on memory and has been broadened so as to cover the phenomenon of the immediate after-effect of a sensory experience, *i.e.* the tendency of the psychical effect to continue active after the cessation of the external stimulus; examples of this after-effect are the apparent continuity of the electric spark and the fusion of colours on a rotating colour wheel. The concept has undergone still further extension in another direction. The observations of Lankes and other investigators have shown that ideas, after having lapsed from consciousness, may persist unconsciously and in an important degree, modify or even hinder succeeding mental processes. According to this fuller concept of perseveration, an idea, after lapsing from consciousness, may continue its activity in the form of an after-effect which modifies succeeding mental processes, the immediate after-effect and the spontaneous recurrence of an idea being particular forms in which this tendency to continued activity is displayed. The ‘secondary function’ ascribed to ideas in the theory of Gross, Heymans and Wiersma would, on this view, be identified with perseveration.

B. PREVIOUS WORK.

i. BEFORE LANKES.

Müller and Pilzecker investigated the phenomenon of perseveration in the course of their work on memory. The ‘scoring’ method was employed in this work and evidence of perseveration was obtained by study of the incorrect responses returned by subjects. Syllables which had been given as correct responses earlier in a series would reappear as

¹ Müller u. Pilzecker, “Exper. Beit. z. Lehre v. Gedächtniss,” *Z. für Psych., Ergänzungsband 1*, p. 58.

incorrect responses later in the same series. Certain syllables showed a tendency to appear as responses on several days. The perseveration tendency of syllables was found to be stronger with fresh series (series tested shortly after presentation) than with older series. Large individual differences were found to exist, the most marked being shown by Müller and his wife. In the case of the latter, perseveration was almost absent, while with Müller it was present in a very high degree. Observation of this pair showed how perseveration operates in normal life. Thus the husband experienced difficulty in leaving a task, but he was able to resume readily a task which had been interrupted; with him, too, resolutions and small commissions were more likely to be carried out; in his dreams there was a tendency for more recent experiences to appear. The wife, on the other hand, greatly excelled the husband in tasks depending upon association, as for instance in the learning of a language.

Foster¹ repeated Müller and Pilzecker's experiments, using the 'saving' method in addition to the 'scoring' method. While similar results were obtained, Foster endeavours to account for the incorrect responses solely by means of association.

The experiments so far described were concerned with the spontaneous recurrence of ideas. The phenomenon of the immediate after-effect of sensation was investigated by Wiersma². By employing a modification of Heymans' experiment on the inhibitory effect of strong visual stimuli on feeble visual stimuli, he observed the length of time during which the after-effect of a strong visual sensation masked an active light sensation of low intensity. In a similar experiment with pain sensations, the duration of the after-effect of a pain sensation in one hand caused by the application of a strong faradaic current was measured by noting the length of time during which a much weaker active pain sensation in the other hand (caused in the same way) could not be felt. A third measure of the sensory after-effect in a subject was obtained by employing a colour-wheel with red and blue-green sectors and noting the speed at which the colours completely fused. Subjects in whom the after-effect of the colour sensations was strong required a much lower speed of rotation for fusion than those in whom the after-effect was weak. Wiersma found large differences not only among individual subjects but between the two groups of subjects—one normal and the other abnormal—on whom the experiments were performed.

¹ Foster, "On the Perseverative Tendency," *Amer. Journ. of Psych.* 1914, **25**, p. 393.

² Wiersma, "Die Sekundarfunktion bei Psychosen," *Journ. für Psych. u. Neurologie*, 1906, **8**, Nos. 1 and 2.

ii. LANKES.

The range of the experiments employed in the investigations just described was limited, it will be noted, to some one aspect of perseveration. A far wider range was covered by the work of Lankes¹, who applied to large groups of subjects an elaborate series of tests in which every aspect of perseveration was submitted to examination. The sensory after-effect was tested by means of Wiersma's colour-disc experiment. The continuance, either subconscious or unconscious, of the effect of a past experience was measured by the degree of hindrance which this effect offers to a new mental experience of the same kind. A number of tests were devised to measure this hindrance effect. Briefly, these tests were as follows: (1) Letter-writing. After writing for a given time a set of letters, as hijklmn, the subject was required to write these in the reverse order. (2) Cancellation. A strong 'set' was established for one group of letters, C O S X, by long practice in cancelling these letters. An entirely new group of letters was then given to the subject to cancel. (3) Drawings. Two drawings of similar design were exposed a number of times alternately. The interference due to the perseverating effect of the two perceptions in the reproduction of the two drawings was measured by comparing the drawing made by subjects of a copy exposed singly. (4) Narratives. Two stories, bearing many points of resemblance were read to the subjects and a set of similar questions asked on each story. (5) Comparisons. The subjects were required to make a comparison between two given themes, e.g. Railway and Telegraph, Thames and Rhine, etc. For some comparisons a large time allowance was given, and for others only a short time was allowed. The hindrance effect due to perseveration would be expected to be greater with the short time allowance than with the larger allowance: a comparison of the two performances in these two times would give a measure of this effect. (6) Tapping. The natural rate of tapping of a subject was regarded as an indication of his perseveration tendency, as strong perseverators would, in general, display a preference for a slower rate. The subjects were also given an interrogatory which, in effect, constituted a systematised introspection on their perseverative tendency. Two important results emerged from Lankes' work. In the first place, the results clearly established the existence of a group factor of perseveration, the factor being very small with normal subjects. The second result effected a revolution in the conception of perseveration. All previous workers in

¹ Lankes, "Perseveration," *Brit. Journ. of Psych.* 1915, 7, p. 387.

perseveration had taken a wide view of this trait and had assumed a close connection between it and the will. Lankes, however, found that perseveration is independent of the will, its operation being confined to the cognitive side of consciousness. He further found that there was a large negative correlation with the perseveration qualities of the will, which he interpreted as indicating that perseveration may actually be counteracted by a strong will. Dr Wynn Jones¹ applied a series of ten tests, all based on the same principle as that employed by Lankes, to a group of adults and of school children. The results, which have not yet been published, confirm the conclusion arrived at by Lankes as to the existence of a small group factor.

C. OWN TESTS.

In the present enquiry ten tests for perseveration were applied to two groups of school children numbering respectively 60 and 70. Only those of Lankes' tests as were suitable for 'mass' application were used and for this purpose the Tapping and the Alphabet (Letter Writing) Tests were chosen. Dr Wynn Jones kindly supplied the Inverted S, Reverse Stroke, Mirror Image and 'IT' Tests. The remaining four tests were specially devised for the present work. In all ten tests, the 'hindrance' principle of Lankes was employed; it may be noted that Wiersma had used a test, in the work previously referred to, embodying the same principle.

a. THE TESTS.

1. Description of Perseveration Tests employed.

P₁. *Tapping Test.*

The subjects were told to close their eyes and to tap in the air with a finger of the right or left hand, imagining that they were tapping something solid. The subjects were told to tap at any rate they desired and to count mentally the number of taps they made. The time allowed for this test was 30 seconds, the experimenter giving the signal 'Ready—begin.' The test was given twice—at the beginning and at the end of the first morning on which the main tests were given. The number of taps made in each test was entered by each subject on a slip of paper containing his name.

Details of the method of marking this and the other perseveration tests are given later.

¹ Jones, "Perseveration," *Report Brit. Assoc. for Adv. of Science*, 1915, p. 698.

P₂. Inverted S Test.

(a) The subjects were instructed to write "S S S S ..." as fast as possible for 30 secs. (b) The subjects were then told to write the reversed letter "S S S S ..." as fast as possible for 30 secs. (a) and (b) were next repeated twice. (c) The subjects were finally told to write

"S S S S S S S S..."

for three minutes. The full procedure was therefore as follows:

(1) "S S S S ..."	30 secs.	(5) "S S S S ..."	30 secs.
(2) "S S S S ..."	30 ,,	(6) "S S S S S S ..."	30 ,,
(3) "S S S S ..."	30 ,,	(7) "S S S S S S S S ..."	3 mins.
(4) "S S S S ..."	30 ,,		

The whole test was first explained on the black-board before being given. The signal for commencing was 'Ready—begin.' After every 30 seconds the signal 'Change' was given, the subjects starting the series on a fresh line. A few seconds' pause was allowed before commencing (7), a separate signal 'Ready—begin' being given. At half-time ($1\frac{1}{2}$ minutes) in No. 7 the signal 'Cross' was given, the subjects marking with a cross the point they had reached. Two seconds were allowed for marking the cross, the subjects then resuming the task set.

P₃. Reverse Stroke Test.

(a) The subjects were instructed to write the figures

2 3 4 5 6 7 2 3 4 5 6 7 ...

as rapidly as possible for one minute.

(b) The subjects were then told to write the same figures for three minutes, each figure being written with a 'reverse stroke.' Thus figure 4_x is started with the line l_x (commencing at x); next \sim_x (commencing at x); lastly $x/$, so that the complete figure is written with the component parts written in the reverse order and in the reverse direction.

Similarly 6 was started thus $x\circ$ and finished with $x\backslash$; 7_x was started at x thus $\%_x$, and continued from o thus \sim^o . The method of writing the figures with the reverse stroke was explained to the subjects before giving the test, the subjects being allowed to practise writing 23...7 in reverse stroke once. The signal for both (a) and (b) was 'Ready—start,' and at half-time in (b) 'Cross' was called out for subjects to mark with a cross the point they had reached.

P₄. Mirror Image Test.

(a) The subjects were instructed to print the letters B C D E F G as fast as possible for one minute.

(b) The subjects were then told to print the letters for three minutes in the form they have when seen in a mirror, *i.e.* B E D G . F H E D C .

Before working the test the subjects were allowed to practise printing the letters once in the mirror form.

The signals were given as in P₃, and half-way point marked with a cross.

P₅. 'IT' Test.

(a) The subjects were given sheet P₅ (see below for copy) and asked to copy the passage printed on it, writing as fast as possible—time allowed two minutes. The subjects were warned to be careful to dot i's and to cross t's.

(b) The subjects were told to copy the passage again, this time *refraining* from dotting i's and crossing t's. An illustrative example was given on the black-board: 'dictation' written as dictation. Subjects were warned not to stop at errors (*i.e.* when t was crossed or i dotted) but to go right on as fast as possible. The signals given were as in previous two tests, the half-way point being marked with a cross as before. Time allowed for (b), four minutes.

P₅. The boy listened with rapt attention to the sweet music. At last silence reigned again. The brilliant illumination revealed the silent player. Running up to him the lad took the instrument and asked to be taught how to play it. Sitting at his feet the lad plucked the strings while his teacher guided his fingers. After a while they left the cave attracted by a noise outside. Seeing a group of boys dancing and wrestling upon a plot of grass they joined in their play till night fell. Rising at dawn after a refreshing sleep they bathed in the torrent and then went on their way. In the distance they could see the faint outline of a mountain with smoke rising from it. Quickenning their pace they at length reached a house at the foot. They tried to gain admission but an ominous silence warned them to discontinue their efforts to enter.

P₆. Alphabet Test.

(a) The subjects were instructed to write the letters lmnopq as one word as fast as possible. Time allowed $\frac{3}{4}$ minute.

(b) The subjects were then asked to write these letters in the reverse order, again as one word (*i.e.* qponml). Time allowed $1\frac{1}{2}$ minutes.

(c) The letters rstuvwxyz were treated in the same way, being written as one word, as fast as possible, for $\frac{3}{4}$ minute and then

(d) Written in the reverse order as one word—wvutsr—as fast as possible for $1\frac{1}{2}$ minutes.

The signals given were as in the three preceding tests. In (b) and (d) 'Cross' was called out at half-time and a cross marked by the subjects to indicate the point reached in the tests.

P₇. Triangles Test.

(a) The subjects were instructed to draw a series of triangles—apex upwards—as fast as possible for 30 seconds; thus: △△△△....

(b) A similar series was then drawn, with apex downwards, as fast as possible for 30 seconds; thus: ▽▽▽▽....

(c) Subjects repeated (a) and (b) twice.

(d) The subjects finally drew as rapidly as possible for three minutes the following series: △▽△▽△▽△....

The full procedure for this test was therefore as follows:

(1) △△△...	for 30 secs.	(5) △△△...	for 30 secs.
(2) ▽▽▽...	"	(6) ▽▽▽...	"
(3) △△△...	"	(7) △▽△▽△▽△...	for 3 mins.
(4) ▽▽▽...	"		

The test was explained on the black-board before being given. The signal for commencing was, as before, 'Ready—begin.' After each 30 seconds 'Change' was called out, the new series of triangles being then commenced on a new line. No. 7 was started separately after an interval of a few seconds; 'Cross' was called out as before at half-time.

P₈. Capitals Test.

(a) The subjects were given the hektographed sheet *P₈* (see copy below) and were instructed to copy the passage on the sheet exactly as given—writing capital letters where these appeared, etc.—and writing as fast as possible. Time allowed 2½ minutes.

(b) The subjects were then asked to copy the passage again, this time writing a capital letter wherever a small letter appeared, and a small letter in place of every capital letter: all letters were to be written—not printed. An illustrative example was given, thus:

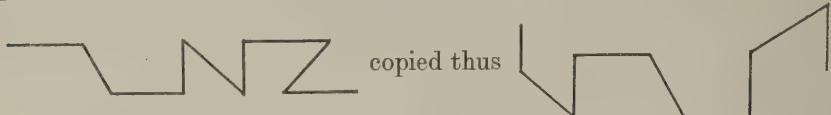
"The Duke DREW his sword" was to be written as "tHE dUKE drew HIS SWORD." The signals were given as in Tests 4, 5, 6, a cross being marked in (b) as before.

P₈. The Captain of R.M.S. "India," John Smith, shouted "MAN THE BOATS!" as the SHIP sank. The AGONISED cries of women AND CHILDREN struggling in THE WATER could be HEARD by ALL. The SON of King HAL, Prince James of AYRLE sent a STRONG FORCE to bring to JUSTICE all who were CONCERNED in THE plot. Cries of DELIGHT from the CHILDREN greeted the APPEARANCE of a Christmas TREE loaded WITH TOYS of ALL kinds. The ALLIED Armies advanced VICTORIOUSLY AGAINST the Germans, STORMING their Trenches and PIERCING their DEFENSIVE Positions EVERYwhere.

P₉. Vertical Horizontal Test.

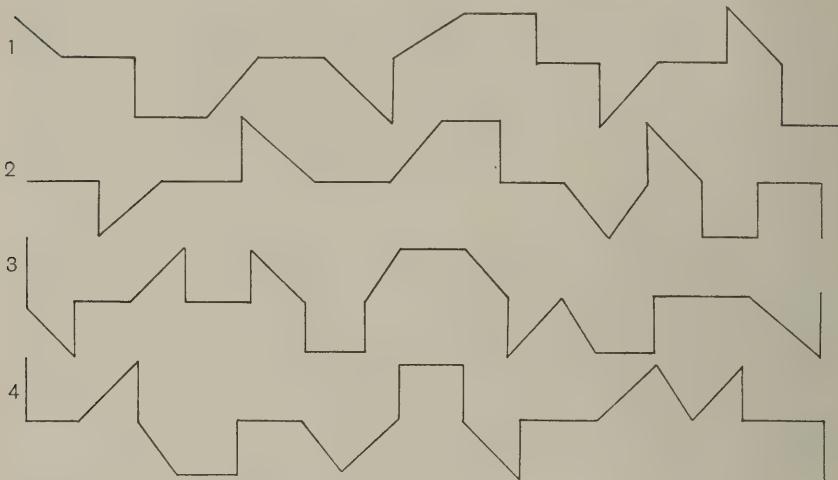
(a) The subjects were given a hektographed copy of *P₉*, and were asked to reproduce the four rows of simple geometrical patterns—keeping the size about the same as the original. Time allowed 1 minute.

(b) The subjects were then asked to copy the patterns again, but on this occasion drawing a horizontal line wherever a vertical line occurred, and a vertical line in place of every horizontal line; oblique lines were to be copied as they appeared in the original. The procedure was explained on the black-board by means of the following example:



The signals were given as in the preceding test, a cross being marked in (b) at half-time. Time allowed for (b) 2 minutes.

P9.

P₁₀. 'EA' Test.

(a) The subjects were given the hektographed sheet P₁₀ (see below) and were asked to copy the passage. Time allowed 2 minutes.

(b) The subjects were asked to copy the passage again, on this occasion writing 'a' after 'e' wherever the letter 'e' occurred on the sheet. The following examples were given to indicate what was required:

'redeemer' written as 'readeaeeamear' and 'breathe' written as 'breaathea.' Time allowed 4 minutes.

The signals were given as in the preceding tests, the half-time point being marked in (b) with a cross as in previous tests.

P₁₀. I knew their plan. They had a map and an almanack and designed for Grangemouth where they were to steal a ship. Suppose them to do so, I had no idea they were qualified to manage it after it was stolen. Their whole escape indeed was the most hazardous thing imaginable: only the impatience of captives and the ignorance of private soldiers could have devised a scheme foredoomed to failure from the outset.

PERSEVERATION

13

Marking of Perseveration Tests.

P₁. Tapping Test. The score in this test was taken to be the sum of the number of taps made in the two tests.

P₂. If A = total no. of S and Z written in Nos. 1 to 6 and T = no. written in 7, score = T - A. (For every mistake in 7, one mark deducted.)

P₃. Score = T - 3A, where T = no. of reverse stroke figures in (b) - no. of mistakes in (b), and A = no. of figures done in (a).

P₄. Score = T - 3A, where T = no. of 'mirror' letters written in (b) - no. of mistakes made in (b), and A = no. of letters done in (a).

P₅. Score = T - 2A, where T = no. of words written in (b) - no. of 'i's' dotted and 't's' crossed, and A = no. of words written in (a).

P₆. Score = T - 2A, where T = no. of letters written in (b) and (d) together - no. of mistakes, and A = no. of letters written in (a) and (c).

P₇. Score = T - A, where T = no. of triangles drawn in No. 7 - no. of mistakes, and A = total no. of triangles done in Nos. 1 to 6.

P₈. Score = T - 2A, where T = no. of words written in (b) - no. of mistakes, and A = no. of words written in (a).

P₉. Score = T - 2A, where T = no. of lines drawn in (b) - no. of mistakes, and A = no. of lines drawn in (a).

P₁₀. Score = T - 2A, where T = no. of words done in (b) - no. of mistakes, and A = no. of words done in (a).

TABLE A. PERSEVERATION TESTS.

Intercorrelations for Group 2 (70 subjects).

		P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉	P ₁₀
		Tapping	Inverted 'S'	Reverse stroke	Mirror image	'IT' test	Reversed alphabet	Triangles	Capitals	Horizontal vertical	'EA' test
P ₁	Tapping	751 033	-368 068	339 070	088 079	-065 080	-096 079	-053 080	112 079	-088 079	-282 073
P ₂	Inverted 'S'	-368 068	882 020	-119 079	453 062	220 076	155 078	278 073	005 080	112 079	240 075
P ₃	Reverse stroke	339 070	-119 079	749 037	309 072	162 078	023 080	191 077	226 075	194 077	078 080
P ₄	Mirror image	088 079	453 062	309 072	933 017	142 068	111 083	182 077	282 073	233 075	198 077
P ₅	'IT' test	-065 080	220 076	162 078	142 078	601 055	-023 080	051 080	002 080	008 079	-088 079
P ₆	Reversed alphabet	-096 079	155 078	023 080	111 079	-023 080	712 042	004 080	-051 080	208 076	048 080
P ₇	Triangles	-053 080	278 073	191 077	182 077	051 080	004 080	702 043	114 079	143 078	223 076
P ₈	Capitals	112 079	005 080	226 075	282 073	002 080	-051 080	114 079	621 053	108 079	130 079
P ₉	Horiz.-vertical	-088 079	112 079	194 077	233 075	008 080	208 076	143 078	108 079	658 048	142 078
P ₁₀	'EA' test	-282 073	240 075	078 080	198 077	-088 079	048 080	223 076	130 079	142 078	364 069
	Av. correlation	-046 080	108 079	156 078	222 076	045 080	042 080	126 079	103 079	118 079	076 080

QUICKNESS AND INTELLIGENCE

TABLE B. PERSEVERATION TESTS.
Intercorrelations for Group 3 (60 subjects).

		P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉	P ₁₀
		Tapping	Inverted 'S'	Reverse stroke.	Mirror image	'IT' test	Alphabet	Triangles	Capitals	Horizontal- vertical	'EA' test
P ₁	Tapping	814 028	302 080	231 083	264 082	181 085	062 088	301 080	214 084	-104 087	-208 084
P ₂	Inverted 'S'	302 080	846 022	254 083	221 084	246 083	148 086	169 086	-051 088	-053 088	-225 083
P ₃	Reverse stroke	231 083	254 083	773 034	269 082	153 086	091 087	-092 087	212 084	116 087	-141 086
P ₄	Mirror image	264 082	221 084	269 082	868 019	301 080	-170 086	257 082	290 081	198 085	-098 087
P ₅	'IT' test	181 085	246 083	153 086	301 080	687 047	061 088	126 087	146 086	260 082	046 088
P ₆	Alphabet	062 085	148 086	091 087	-170 086	061 088	775 033	051 088	-010 088	-003 088	-016 088
P ₇	Triangles	301 080	169 086	-092 087	257 082	126 087	051 088	814 028	202 085	-115 087	-022 088
P ₈	Capitals	214 084	-051 088	212 084	290 081	146 086	-010 088	202 085	674 047	226 083	-026 088
P ₉	Horiz.- vertical	-104 087	-053 088	116 087	198 084	260 082	-003 088	-115 087	226 083	631 052	103 087
P ₁₀	'EA' test	-208 084	-225 083	-141 086	-098 085	046 088	-016 088	-022 088	-026 088	103 087	488 066
	Av. cor- relation	138 086	112 087	121 087	170 086	169 086	024 088	098 087	134 087	070 088	-065 088

2. Results.

i. Correlations.

Tables A and B give the intercorrelations for the ten tests for both groups of subjects (Groups 2 and 3). The product-moment formula $r = \frac{\Sigma(xy)}{n\sigma_x\sigma_y}$ was employed for the calculation of the correlations. The

probable error $(\cdot 6745 \frac{1 - r^2}{\sqrt{n}})$ for each coefficient is shown in italics.

In both groups it will be observed that each test, with one exception, shows a positive average correlation with all the other tests. It was necessary, for purposes to be described later, to secure a measure of

TABLE C. PERSEVERATION TESTS SELECTED FOR POOLING.

Group 2.

	P ₂	P ₃	P ₄	P ₇	P ₈	P ₉
P ₂	882 020	-119 079	453 066	278 073	005 080	112 079
P ₃	-119 079	749 037	309 072	191 077	226 075	194 077
P ₄	453 066	309 072	933 017	182 077	282 073	233 075
P ₇	278 073	191 077	182 077	702 043	114 079	143 078
P ₈	005 080	226 079	282 073	114 079	621 053	108 079
P ₉	112 079	194 077	233 075	143 078	108 079	658 048
Av. correlation	148 082	160 082	292 077	182 081	147 082	158 082

Group 3.

	P ₁	P ₂	P ₃	P ₄	P ₅	P ₇	P ₈	P ₉
P ₁	814 028	302 080	231 083	264 082	181 085	301 080	214 084	-104 087
P ₂	302 080	846 022	254 083	221 084	246 083	169 086	-051 088	-053 088
P ₃	231 083	254 083	773 034	269 082	153 086	-092 087	212 084	116 087
P ₄	264 082	221 084	269 082	868 019	301 080	259 082	290 081	198 085
P ₅	181 085	246 083	153 086	301 080	687 047	126 087	146 086	260 082
P ₇	301 080	169 086	-092 087	257 082	126 087	814 028	202 085	-115 087
P ₈	214 084	-051 088	212 084	290 081	146 086	202 085	674 047	226 083
P ₉	-104 087	053 088	116 087	198 084	260 082	-115 087	226 083	631 052
Av. correlation	199 085	170 086	163 086	257 082	202 084	121 087	177 085	075 087

perseveration for each subject. The desired measure was obtained by pooling the scores obtained in those tests showing the highest average correlation, the scores being 'weighted' to produce equal standard deviations. The following tests were selected for pooling: Group 2: P₂, P₃, P₄, P₇, P₈, P₉; Group 3: P₁, P₂, P₃, P₄, P₅, P₇, P₈, P₉. The tables on the previous page show the correlations for these tests.

The selected tests have an appreciable positive correlation with one another—the average correlation for Group 2 is $\cdot181 \pm \cdot081$ and for Group 3 $\cdot171 \pm \cdot086$. Lankes obtained a slightly higher average inter-correlation with his tests; the results obtained by Dr Wynn Jones were very similar to those recorded here.

ii. *Reliability of the Tests.*

The reliability coefficients were obtained by calculating the correlation between the performance in the first half and second half of each test. This was rendered a simple matter by the subjects having marked in all tests the point reached at half-time. The coefficients are shown in Tables A and B by figures in heavy type. With the exception of P₁₀ the reliability is high for all tests, none being below $\cdot6$ and the majority being above $\cdot7$.

b. ESTIMATE OF PERSEVERATION.

i. *Sources.*

In previous work on perseveration no effort was made to obtain an estimate of this quality in subjects. The nature of the quality renders its estimation difficult: true evaluation can be accomplished only on the basis of careful introspection. Perhaps the nearest approach to an estimate was that made by Lankes in his interrogatory test, and it is interesting to note that this test correlated highly with the other tests. For the purposes of the present enquiry, it was desirable to obtain additional evidence as to the adequacy of the perseveration score (pool of scores in selected tests) to measure the trait. An attempt was therefore made to obtain an estimate of perseveration on the basis of observation as opposed to tests. It was noted, in the course of observations made on the subjects (to be described more fully later), that large differences were displayed in the ease with which the subjects started work on any given task; some would become immersed almost at once in the task, while others would take an appreciable time in settling down to work. An estimate was therefore sought on this basis. Observation was

made on the capacity of the boys to adapt themselves to change in conditions of class work. Those showing least adaptability to new work, taking an inordinate time to settle down to any task and perhaps finding themselves compelled to rush through a great deal of work in the last few minutes in order to produce a tolerable output were classed as the highest perseverators; those at the other extreme, who never appeared to experience any difficulty in starting and who quickly adapted themselves to any change imposed in the work, were classed as non-perseverators; boys showing degrees of adaptability intermediate between these were classified accordingly. The scale employed ranged from + 3 for high perseverators to - 3 for low perseverators. The most favourable tasks for the purposes of this estimate were those requiring a comparatively short time—15 to 20 minutes; as in the longer tasks the larger time allowance compensated for difficulty of adaptation.

ii. *Reliability of Estimates of Perseveration.*

For each group two independent estimates were obtained. The correlation between the two estimates was .48 for Group 2 and .52 for Group 3; in neither group, therefore, is the reliability of the estimate very high. The low reliability can be accounted for in several ways. The field of observation on which the estimates were based is exceptionally narrow, and the personal bias of the observer is magnified to a corresponding degree. Further, perseveration is peculiarly liable to simulation; an observer may be inclined to regard any sort of slow starting as due to the operation of perseveration, although other factors may actually be responsible such as general disinclination to work, physical condition, dislike for the special task set, etc. The differences in the estimates of the teachers may reflect in a high degree differences in the influence of the teachers on the boys. As is well known, pupils do not react equally with different teachers. Where one teacher may succeed in securing a great output of effort in a class, another may only obtain a fair response. A boy who does well with one teacher, may be only mediocre with another, not because of any essential difference in ability in the teachers, but because something in the personality of one makes a special appeal to the boy. Altogether, therefore, with the sources available for the estimate a high reliability is not to be expected.

iii. *Correlations between Tests and Estimate.*

The following table gives the correlation of the estimate with the individual tests:

Group	Tapping	Inverted 'S'	Reverse stroke	Mirror image	'IT'	Alphabet	Triangles	Capitals	Lines	'EA'
2	.17 078	.44 064	.16 078	.33 071	.30 072	.18 077	.17 078	.14 078	.15 078	.08 080
3	.36 075	.34 077	.21 084	.46 069	.42 072	.23 083	.32 079	.30 080	.31 079	.11 087

The correlations, while not high, are a fair indication that the tests themselves are reasonably adequate as a measure of perseveration; as noted above, the estimate is, at best, only approximate. The correlations in the third group are almost uniformly higher than those in the second group; this difference is certainly in part due to the fact that the estimates were formed by different teachers in the two groups. Considerably higher correlations are obtained when the coefficients are corrected for the various errors which are inseparable from measurements such as those under consideration. Applying the Spearman correction formula

$$r_{(ep)} = r_{ep} \sqrt{\frac{1 + r_{e_1 e_2}}{2r_{e_1 e_2}} \cdot \frac{1 + r_{p_1 p_2}}{2r_{p_1 p_2}}},$$

where r_{ep} is the coefficient of correlation between estimate and a perseveration test, $r_{(ep)}$ is the desired corrected coefficient and $r_{e_1 e_2}$, $r_{p_1 p_2}$ are reliability coefficients of the estimate and perseveration tests, the following corrected coefficients are obtained:

Group	Tapping	Inverted 'S'	Reverse stroke	Mirror image	'IT'	Alphabet	Triangles	Capitals	Lines	'EA'
2	.23 075	.58 052	.22 076	.41 066	.46 062	.25 075	.24 075	.20 077	.21 076	.14 078
3	.47 068	.44 070	.29 081	.59 056	.58 058	.32 079	.42 072	.42 072	.43 071	.17 086

The correlation between estimate and pool of all tests is .48 for Group 2 and .54 for Group 3.

III. THE MAIN ENQUIRY.

A. PRELIMINARY CLASS OBSERVATIONS.

The first proceeding in the investigation of speed differences consisted in careful and prolonged observation of the subjects in the course of their ordinary schoolwork under the experimenter's own tuition. The observations extended over some months and served the double purpose of throwing light on the nature of these speed differences and of indicating the lines which the enquiry could most usefully follow. The subjects of these preliminary class observations were boys of the Third Year class of a L.C.C. Central School, the average age being 14. In order that the speed differences observed should be complicated as little as possible by differences in general ability, the observations were confined to groups of subjects equal among themselves in intelligence. There were three such groups, each necessarily small; the 'good' group contained nine subjects, the 'medium' group 11 subjects and the 'poor' group eight subjects.

The chief methods employed while the observations were in progress may be roughly classified as follows: (a) oral questions, arising in the ordinary course of the work of the class, were put to the boys, (b) special questions, both oral and written, unconnected with the class-work were also asked, (c) observation was made of the boys when free from class conditions—in the playground, at games, on school excursions, etc., (d) observation was also made while written work was in progress in the class. Special opportunities for observation were afforded when the class was being taken by some specialist teacher (*e.g.* science teacher) as the experimenter was then in the position of an onlooker.

The oral work of the class lent itself admirably for observational purposes. As a rule, one group at a time was kept under observation—usually for two days, and the quickness of the response of the individuals in the group was noted. The most obvious speed differences observed were those following the lines of cleavage in the interests of the boys. One boy, for instance, invariably out-distanced the others in the group in answering questions in geography; his written work showed no such marked superiority—indeed better work was done by at least two other boys. Yet he was most 'alive' in this subject, all alert for 'attack' from whichever quarter this might come, ready to pounce upon a question the moment it was delivered. Other boys showed a similar excellence in science and in language questions, their greater interest in these subjects giving them the advantage of a greater readiness in meeting questions.

The most striking instance of this preference was that of a boy in the second ('medium') group who surpassed several boys in the first group in oral work in geometry; his paper work in this subject did not show the same superiority, but he was easily the fastest in both comprehending and in supplying answers to questions.

Conative differences were noted as being responsible for speed differences with several boys. On the one hand were the 'triers' in whom the effort to answer questions was always evident; with them to make an answer of some sort was almost a duty, even though such answer might be nothing better than a shot. On the other hand, were those in whom conation was defective; effort to answer questions was either absent, or required too much time to be effective. It is interesting to note that the dullest group contained the largest proportion of the second type, the differences in speed in this group being very clearly traceable to differences in conation. Only one case of defective conation was found in the first group.

Close observation of the boys during questioning revealed the fact that 'slowness' need be only apparent and not real; a semblance of 'slowness' was given by (a) physical defects, or by (b) temperamental peculiarities. One boy in the first group stammered so badly that he abandoned any effort to participate in the oral work. To a stranger he might easily appear slow and even stupid. In his written work, however, he easily held his own, both in quality and in speed, with others of his group. In another case belonging to the same group, sheer inanition was responsible for what appeared to be extreme slowness. Constant under-feeding, due to bad home conditions, reduced the boy to such a state of feebleness, that even his written work, as well as his oral work, was marked by extreme slowness. Private talks with this boy and examination of his written work showed him to have one of the best intellects of the class.

That temperamental peculiarities were responsible for slowness observed in some cases was shown by a comparison of behaviour inside and outside the class. In the case of two boys in the second group extreme nervousness prevented them from doing full justice to themselves in the oral work of the class; in one of these cases there was present, too, a lack of self-confidence which showed itself in a fear that the answer must be wrong. (It is worthy of mention that such a fear is common among boys with intelligence rather below the average.) Once removed from the disconcerting atmosphere of the school-room, both boys showed alertness equal to that of other boys in their group.

Observation revealed a class of thinkers of a deliberate type who preferred to sacrifice speed to accuracy. These boys would not venture to answer until they had satisfied themselves that they had given the question sufficient consideration. Guesswork of any kind was avoided by them, while their written work was marked by most painstaking effort. This class was more readily identified when special questions were set, not related to the class work. The common element of these questions was some slight inconsistency which the boys were required to detect. Several questions were modelled after the type of 'absurdities' employed by Binet; in others, the inaccuracies so frequent in newspaper reporting formed the material; simple puzzles and problems were also occasionally set. The questions were in most cases written on a blackboard, and at times given on hektographed sheets—samples of these sheets are given below. The time taken by individuals to supply written answers was noted. With these questions the answers supplied by boys of the 'deliberate' type were among the best, although too among the slowest.

1. An engineer said that the more carriages he had on his train the faster he could go.
2. In the first few rounds of a fight, a boxer was severely punished, both his jaw and arm being broken. He luckily went on fighting and secured a draw.
3. A dealer in eggs was once asked by a customer if the eggs he was selling would yield cocks or hens if hatched. "I cannot tell you," he replied, "as I have been in this business only a week."
1. A man was sent to prison for marrying his widow's sister.
2. The following notice was put up at an enquiry office: "All who cannot read English should apply to the manager."
3. A minister offered up prayers in Church for rain to aid the crops. A few days later such heavy rain fell that the crops were damaged. An old farmer said "That is the worst of having prayers for rain offered by a minister who knows nothing of farming."

As noted previously, the written work of the boys provided favourable opportunity for observing boys of the 'perseverating' type. These boys were conspicuous by their slowness in starting and were always the last to settle down to a given task. A similar lack of adaptability to sharp change was displayed by them in all the school work. The boys of the 'deliberate' type differed from this 'perseverating' type in their uniform speed in written work: with them not only was the start slow, but the whole of the work was done slowly, the dominant consideration being to produce careful, neat and accurate work.

Observation of the boys outside the class was of value chiefly for correcting any wrong impressions of 'slowness' which behaviour inside class might have given. Sharp differences were shown by boys most affected by class-room conditions. A boy, so reserved in school as to appear extremely slow, vied with the rest in alertness—he would be quick

in repartee, show a swift understanding of the intentions of his fellows and display a shrewdness which his class-room behaviour would never lead one to suspect.

Outside conditions afforded better opportunities of noting a boy's resourcefulness—his quickness in appreciating the difficulty of a situation and in dealing with it. It was noted that boys who had displayed perseverative tendencies in class were not so ready as others in dealing with difficult situations.

The result of this preliminary class observation may now be summarised. The differences in 'slowness' exhibited by the boys appeared to be traceable to one or more of the following factors:

- (a) Differences in interests.
- (b) Conative differences—as shown by the differences in the degree of effort exerted both in apprehending and in answering questions.
- (c) Physical defects.
- (d) Temperamental peculiarities—such as extreme nervousness, lack of self-confidence, etc.
- (e) Domination by aim to secure accuracy, etc. ('Deliberate' Type).
- (f) Perseveration.

Over and above these, there still remains as a possible factor, a general speed ability. It may be stated that, before the present enquiry was undertaken, the writer held the view that a speed factor existed independently of the factor of general ability. Observation, however, did not supply any clear evidence in favour of such a factor; not only were cases of extreme slowness explicable on other grounds, but the degree of slowness appeared to be determinable by the grade of intelligence. The problem called for a more systematic investigation than was possible with such observations as were made and in the following sections a description will be given of the method which was followed.

B. THE TESTS.

a. TESTS VERSUS OBSERVATION.

In the preceding section, various factors have been described which appeared to account for the speed differences observed among the subjects. These results were obtained on the basis of observation alone. On several grounds, however, the employment of tests seems better adapted than observation for the purpose of identifying factors producing speed differences. It was seen, for instance, that differences in the preferences exhibited by boys towards different class subjects were responsible in part for differences in speed. With tests, no such differences in preference are likely: the tests place all the boys on an equality as far

as preference is concerned. Nor do conative differences come into play when tests are used, for nothing is more marked than the zest with which the boys, as a whole, attack the tests. Boys who seem to be lamentably deficient in volition where school-work is concerned develop a most healthy will when tests replace school tasks: the laziest vie with the most energetic in the zeal displayed. The effect of such physical defects and temperamental peculiarities as have been described is, in the main, eliminated by the use of tests. Finally, it has already been shown that perseveration is susceptible of measurement by suitable tests. It seems, therefore, that the use of tests is most likely to lead to the elucidation of the problem under consideration. The tests which were employed for the purpose will now be described.

b. PRINCIPLE OF METHOD. 'LEISURE' AND 'HASTE' TESTS.

In essence, the method employed consisted in giving the subjects two kinds of tests: (a) those in which ample time was allowed, (b) those in which the time allowed was too brief for any but the fastest subjects. Slower subjects could fairly be assumed to do relatively better in the first kind of tests ('leisure' tests) than in the second kind ('haste' tests). A comparison of the performances in these two kinds of tests could therefore be expected to throw light on the nature of slowness and its relation to intelligence.

Ten sets of tests were devised embodying this principle. Each set consisted of 20 separate tests, this number being made up of four each of the following five kinds: Sentence Completion, Directions, Comitants, Analogies and Moral Classifications. The four tests in each case varied in length—two being short ('leisure' tests) and the other two long ('haste' tests). Thus each of the five kinds of tests was worked by the subjects at four different speeds.

c. DETAILED DESCRIPTION OF THE TESTS.

i. Sentence Completion Test.

Simple sentences were given with a single word omitted (except in the shorter leisure test, where two words were omitted from each sentence) and the subjects were required to insert the missing words. The lengths of the four tests for the Sentence Completion Test were as follows:

- 'Leisure' Test 1. 4 sentences (each with two words omitted).
- 'Leisure' Test 2. 9 " (" one word ").
- 'Haste' Test 1. 11 " (" " " ").
- 'Haste' Test 2. 16 " (" " " ").

Below are given two sample sheets ('leisure' 1 and 'haste' 2) of this test.

Y₄

TEST 1.

A word is missing in each space marked Insert the missing words in these spaces.

The man who had been run over was badly and lay on the ground suffering great A few minutes an ambulance arrived and him to the hospital. Here it was found that he had both legs and that it would be necessary to him in hospital for a long time. When he became, he sent a gift to the hospital in gratitude for all they had for him.

Y₄

TEST 4.

Each of the following sentences has a word missing. Write the missing word in the space marked

1. He the bread with a knife.
2. He down on a chair for a while.
3. He gave the boy a penny to a newspaper.
4. The carpenter down the lid with a screwdriver.
5. He threw the letter in the fire and it.
6. The teacher wrote on the board with
7. The man recovered from a serious
8. The of the parcel became undone and the contents fell out.
9. He drew a with a compass.
10. The shopkeeper many customers in a few minutes.
11. A square has sides.
12. The man felt sleepy and could hardly keep his open.
13. The field had fine suitable for grazing.
14. Dashing past the porter the man ran the stairs to the first floor.
15. The man made up a of all the things stolen.
16. The angler waited many hours before he his first fish.

It should here be stated that a preliminary trial of the tests showed the necessity of slightly increasing the difficulty of the shorter 'leisure' tests in order to compensate for the greater ease with which these tests could be worked owing to their ample time allowance as compared with the longer 'leisure' test and the two 'haste' tests. In the case of the Sentence Completion Test this was done by omitting two words from each of the sentences in the shorter 'leisure' test.

ii. *Directions Test.*

The subject was required to carry out simple instructions, *e.g.*

"Place a dot above the shortest stroke | | | | ."

"Join the opposite corners of this oblong — — — — ."

In the shorter 'leisure' test the instructions were given in a slightly more difficult form; each sentence, further, contained two

instructions instead of one. The four lengths employed for this test were:

'Leisure' Test 1. 8 directions (slightly more difficult than in the other tests).
'Leisure' Test 2. 10 "
'Haste' Test 1. 11 "
'Haste' Test 2. 16 "

Sample sheets of 'leisure' 1 and 'leisure' 2 are given below.

X₃

TEST 13.

Draw a triangle here and a circle above the last word of this sentence. If you think that December is a hotter month than July put a cross here but if you think that July is hotter, write the letter **H** here and the letter **C** in the other space. Count the number of letters in the word **printed** in heavy type in this sentence and put the number in the last of these squares . Complete this sentence: He went for a in the

X₃

TEST 2.

Carry out the instructions given in the following sentences.

- Cross out the letter after K — B D C K Y F.
- Add a cross to make these two rows equal X X X X
X X X
- Draw a ring round the group of three dots . . .
- Put a cross below the centre of these squares
- Place a comma after the shortest word: mother boy girl
- Cross out the last word of this sentence.
- Give the answer of $12 - 9 =$
- Cross out the sign for pound % £ @
- Make a word by putting a letter between these letters L D
- How many d's are there in deadened?

iii. Concomitants Test.

This test was given in three forms. In the first form used for the shorter 'leisure' test the subject was required to give some concomitant, property, quality or capacity of a given object or animal. Thus, "What has a cow which a horse has not?" "What can a cat do which a dog cannot do?" The test was occasionally complicated in the following manner:

"What have a cat and a bear which a fowl has not?"

"What can oil and wood do which iron cannot do?"

In the second form, used for the longer 'leisure' test, the test was simplified by requiring the subject to underline the word (three words given) which indicated the required concomitant, quality, etc. Thus: "Underline the word telling of something which we often get from a fowl but which we never get from a cow: SUGAR, MILK, EGG."

"Underline the word telling of something which a man and boy can do but which a cat cannot do: EAT, TALK, BITE."

The third form was used for the two 'haste' tests. The subject was required to underline one word of four given words which indicated something usually to be found with a given animal or thing (name printed in capital letters):

Thus: FINGERS glass tree engine knuckle
 SAW medal milk teeth straw

The lengths of the four forms of the Concomitants Test used were:

'Leisure' Test 1. 7 (First form).

'Leisure' Test 2. 10 (Second form).

'Haste' Test 1. 20 (Third form).

'Haste' Test 2. 22 (Third form).

Three sample sheets follow ('leisure' 1, 'leisure' 2, 'haste' 1).

X₂

TEST 19.

Answer the following questions, writing the answer in the space marked

1. What has a monkey which a man has not?
2. What has a coat which a football jersey has not?
3. What are a bee and fly which a bird is not?
4. What are London and Paris which Leeds is not?
5. What can a sheep and a horse do which a fish cannot do?
6. What has a steam engine which a tram has not?
7. What have a brush and fur which wood has not?

X₂

TEST 15.

1. Underline the word telling of something which a bee often does but which a fly never does: EATS, STINGS, FLIES.
2. Underline the word telling of something which is often given to a bird but never to a dog: BONE, MEAT, SEEDS.
3. Underline the word telling of something which a crab and tortoise have but which a winkle and oyster have not: WATER, LEGS, SHELL.
4. Underline the word telling of something which a fowl and eagle have but which a dog has not: HEAD, BODY, BEAK.
5. Underline the word telling of something to be found in the country but never in a town: AIR, PEOPLE, CORNFIELDS.
6. Underline the word telling of what is often to be found on land but never on sea: SKY, TREES, PEOPLE.
7. Underline the word telling what a tailor often uses in his work but which a barber does not use: SCISSORS, RAZOR, NEEDLE.
8. Underline the word telling of something which is always used in cricket but never in football: BALL, FIELD, STUMPS.
9. Underline the word which tells what is to be found at a wedding but not at a funeral: JOY, SORROW, PEOPLE.
10. Underline the word which tells of something which is to be seen at a boxing match but not at a wrestling bout: FALLS, COMBATANTS, PUNCHING.

X₂

TEST 3.

In each of the following underline the word which tells of something which is usually found with what is indicated by the word printed in capital letters.

EXAMPLES: HORSE poker tail fiddle soap
 SALT tall crab whiteness story

1	FAMILY	children	tree	horse	grass
2	CHAIR	desert	turnip	legs	chief
3	WASHING	lid	prayer	window	water
4	ÉLEPHANT	plate	trunk	street	bag
5	SPIDER	valley	throne	web	pine
6	BACK	backbone	soup	friend	vegetable
7	WEDDING	circle	shop	bride	oak
8	JEWELLERY SHOP	sand	flower	fruit	diamonds
9	BOX	honour	lid	wash	church
10	NEWSPAPER	news	nail	prisoner	vegetable
11	LIBRARY	books	fly	county	call
12	PEN KNIFE	music	paint	blade	letter
13	MOON	coal	cat	smell	light
14	PIANO	milk	music	water	before
15	RAILWAY STATION	grass	porters	sheep	fruit
16	ZOO	street	table	animals	fleet
17	AIR RAID	bombs	stamp	nose	board
18	WORKHOUSE	wind	ice	poor people	art
19	TYRANT	rudder	oppression	glass	poem
20	ENEMY	fare	card	rain	hatred

iv. *Analogies.*

This test was given in the form usually employed for this test, three words being given in the form of terms of an arithmetical proportion, the subject being required to supply a fourth word bearing the desired relation with the third word. Thus:

Paris : France :: Berlin : (Germany).
 bear : fur :: bird : (feathers).

In view of the age of the subjects it was necessary to use the simplest analogies: it was found possible, however, to follow a fairly wide range in the difficulty of the analogies used in the test. The test was given in the same form in all four lengths, the shortest length being such as could be comfortably done by a subject working more slowly than the average subject, and the longest test being one which would tax the capacity of the ablest subject. The following were the actual lengths used:

'Leisure' Test 1. 7 analogies
 'Leisure' Test 2. 8 analogies

'Haste' Test 1. 9 analogies
 'Haste' Test 2. 12 analogies

Sample sheets of this test are given below ('leisure' 1, 'haste' 2).

X₁

TEST 11.

In each of the following supply a fourth word in the way shown in the given examples. The word must make with the third word exactly the same sort of pair as the first two words.

Examples: London : England :: Berlin : Germany
 legs : walking :: tongue : speaking
 clothes : body :: stockings : legs

1	one	:	once	::	two	:
2	carpenter	:	wood	::	blacksmith	:
3	day	:	hour	::	minute	:
4	bee	:	hive	::	spider	:
5	sponge	:	soft	::	iron	:
6	ocean	:	big	::	lake	:
7	awake	:	work	::	sleep	:

X₁

TEST 8.

In each of the following supply a fourth word in the way shown in the given examples. The word must make with the third word exactly the same sort of pair as the first two words.

Examples: London : England :: Berlin : Germany
 legs : walking :: tongue : speaking
 clothes : body :: stockings : legs

1	long	:	short	::	strong	:
2	jam	:	sweet	::	vinegar	:
3	wine	:	drink	::	meat	:
4	leather	:	cow	::	gas	:
5	bed	:	sleep	::	desk	:
6	cube	:	square	::	ball	:
7	hill	:	sloping	::	plain	:
8	lark	:	sky	::	frog	:
9	cloth	:	weaving	::	coal	:
10	box	:	wood	::	wall	:
11	chair	:	furniture	::	hammer	:
12	choir	:	voices	::	band	:

v. Moral Classifications Test.

In this test the subjects were required to classify a given action. The test was given in two forms. In the two 'leisure' tests the action was described and three possible classifications were given from which the subjects were required to choose the most fitting classification. Thus:

Boys in a class collect among themselves a small sum in order to send a little gift to a school mate who is in hospital. Underline the word which best describes their action: DUTIFUL, KINDLY, FAIR.

In the two 'haste' tests the procedure was reversed. A classification was given and the subjects were required to select from three given actions the one which best fell under the classification. Thus:

A MEAN ACT. Dangling a piece of string in front of a kitten. Running a batsman out. Upsetting the barrow of a fruit hawker while his back is turned.

In both forms of the test the examples chosen for the test were taken from the life of the subjects, from happenings in class or school, or from history known to them, so that the examples were well within their experiences.

The following were the lengths of the four forms of the test:

'Leisure' Test 1. 8 tests	'Haste' Test 1. 11 tests
'Leisure' Test 2. 9 tests	'Haste' Test 2. 13 tests

Below are given sample sheets ('leisure' 2, 'haste' 2).

Y₄

TEST 18.

1. A nurse struggles with a very powerful patient who is insane and prevents him from committing suicide. Underline the word which best described her act:
MERCIFUL, PLUCKY, GENEROUS.
2. People in Belgium constantly displayed the Belgian flag while the country was occupied by the Germans. How would you describe their conduct? (underline):
GRATEFUL, DECEITFUL, PATRIOTIC.
3. A captain does not give a player who has been fielding all day a chance of batting, although he can easily do so. Underline the word which best describes what this act shows: **UNFAIRNESS, DISRESPECT, HEROISM.**
4. A boy refuses to take to the park a little brother who greatly desires to go. What does this act show? (underline): **INGRATITUDE, UNKINDNESS, COURAGE.**
5. A boy keeps on walking although tired, in order not to spoil the walk for others. Underline the word which best describes what this act shows:
FLATTERY, RESPECT, GRIT.
6. People in the street attend to the injuries of a man who has met with an accident. What kind of act would you say this was? (underline):
HUMANE, MODEST, DECEITFUL.
7. A scorer at a cricket match adds runs to the score of his side. Underline the word which best describes his act: **NOBLE, KIND, CHEATING.**
8. After recovering from a serious illness a man sends a gift to his doctor. What does this act show? (underline): **COURAGE, HONESTY, THANKFULNESS.**
9. Boys laugh and jeer at foreigners who are newly arrived and wear strange clothes. Underline the word which best describes their conduct:
ILL-MANNERED, CRUEL, DISLOYAL.

Y₄

TEST 20.

In each of the following underline what you consider to be an example of the kind of act printed in heavy type.

Example: A cruel act: Frequently coming late. Failing to return things borrowed.
Starving a cat.

1. **Showing good manners:** A man reading a newspaper. Knocking before entering a room. A boy exchanging books with another boy.
2. **An act of flattery:** A man praising another man's work in order to get a favour from him. A doctor feeling a patient's pulse. A merchant doing business.
3. **Frankness:** A boy staying away from school. A boy giving a full account of the part played by him in an unpleasant incident. A man paying taxes.
4. **Showing loyalty:** Sticking to a friend although he has become unpopular. A man paying a debt. A boy buying a football.

5. **Hardhearted conduct:** A lady buying a fowl. A man refusing to go to the help of a child crying piteously. A boy making a model aeroplane.
6. **A merciful act:** King pardoning a man who has made an attempt on his life. A boy learning to row a boat. A man going up in a balloon.
7. **An act showing quarrelsome ness:** Abusing a player because he has accidentally kicked you. A man going to the theatre. A boy going to a football match.
8. **Doing a favour:** A wicket-keeper catching the ball. Reading a letter for a man who cannot read English. Having a photograph taken.
9. **A mean act:** Talking when the teacher's back is turned. Borrowing a boy's rubber. Helping a boy in his work.
10. **An act showing friendliness:** Leaving an overcoat in school. Visiting a friend who is ill and who is feeling very lonely. Playing with a mouth organ.
11. **An act of self-sacrifice:** Using a dictionary for composition. Breaking a glass. Mother wearing herself to death working for her child.
12. **An act of gallantry:** Climbing over a wall. Going to the aid of a policeman attacked by hooligans. Looking for money you have dropped.
13. **A cowardly act:** Stealing books from a boy's desk. Refusing to contribute to a class fund. Allowing a boy to be punished for an offence you have committed.

d. ARRANGEMENT OF THE TESTS. 'ORDERED' AND 'MIXED' SERIES.

The tests previously described were arranged in sets, each set comprising 20 tests. The 20 tests in each set were arranged according to one of two different plans—'ordered' or 'mixed.' Five of the ten sets given to the subjects were arranged according to one plan and the other five according to the second plan. In the 'ordered' arrangement (to be referred to as the Y arrangement) each kind of test was given in turn—first the four lengths of the Completion Test, then the four lengths of the Directions Test and similarly with the Concomitants, Analogies, and Moral Classifications; further, the four lengths in any one test were given in succession—from shortest length to longest. In the 'mixed' arrangement (to be referred to as the X arrangement) no test was followed by another test of the same kind (*e.g.* 'Directions' Test by 'Directions' Test), nor was any one length followed by a similar length ('leisure 1' by 'leisure 1' or 'haste 2' by 'haste 2,' etc.). This 'mixed' arrangement taxed to the utmost the subject's adaptability, as he was required to change rapidly from one kind of test (and speed) to a totally different kind of test (and speed). The 'ordered' arrangement on the other hand did not call for adjustment to rapid changes, but, on the contrary, tended to assist the subject in his adjustment to the change from one test to another kind of test by the arrangement in sequence, from shortest to longest, of the four lengths of any one test. Hence the 'ordered' or Y arrangement was favourable to subjects of the perseverating type. The actual composition of the X and Y series is shown below.

Y ('Ordered')				X ('Mixed')				EXPLANATION.	
1	2	3	4	1	2	3	4	l_1, l_2	='Leisure' Tests.
$A l_1$	$A l_2$	$A h_1$	$A h_2$	$A l_1$	$B l_2$	$C h_1$	$D l_2$	h_1, h_2	='Haste' Tests.
5	6	7	8	5	6	7	8	$E h_1$	Sentence Completion.
$B l_1$	$B l_2$	$B h_1$	$B h_2$	$E h_1$	$C h_2$	$A h_1$	$D h_2$	A	Directions.
9	10	11	12	9	10	11	12	$E l_1$	Concomitants.
$C l_1$	$C l_2$	$C h_1$	$C h_2$	$E l_1$	$B h_1$	$D l_1$	$E l_2$	D	Analogies.
13	14	15	16	13	14	15	16	$B l_1$	Moral Classification.
$D l_1$	$D l_2$	$D h_1$	$D h_2$	$D h_1$	$E h_2$	$C l_1$	$A l_2$	E	
17	18	19	20	17	18	19	20		
$E l_1$	$E l_2$	$E h_1$	$E h_2$						

e. APPLICATION OF THE TESTS.

Two sets were given daily—one series (X) in the morning and the other (Y) in the afternoon, in each case as soon after school assembly as was practicable. The ten sets therefore required five days for their complete application.

The 20 test sheets comprising a set were pinned together and covered with a name slip. The subjects were instructed to work through the tests on each sheet and to turn to the next sheet immediately the signal for doing so was given. The subjects having written name and age on the name slip, the signal for commencing to work through the first test sheet was given. At the expiration of 30 seconds the signal was given to turn to test sheet 2. Thirty seconds was again allowed and the signal for turning to test sheet 3 was given. In this way the whole of the 20 sheets were worked through, 30 seconds being allowed for each sheet. An additional allowance of 2 to 3 seconds was necessary for time consumed in turning from one sheet to another. The signals were given by blowing a whistle. This allowed the experimenter to walk about among the subjects and so exercise closer supervision.

On the completion of each set a perseveration test was given. The ten perseveration tests have already been described in the section dealing with Perseveration.

The following time-table shows the order in which the complete tests were applied, together with the duration of each test:

1st day:	Morning	X ₁	10 mins.	P ₁	1 min.	Afternoon	Y ₁	10 mins.	P ₂	6 mins.
2nd	"	X ₂	"	P ₃	4 mins.	"	Y ₂	"	P ₄	4 "
3rd	"	X ₃	"	P ₅	6 "	"	Y ₃	"	P ₆	4½ "
4th	"	X ₄	"	P ₇	6 "	"	Y ₄	"	P ₈	7½ "
5th	"	X ₅	"	P ₉	3 "	"	Y ₅	"	P ₁₀	6 "

(Note. P₁–P₁₀ are the perseveration tests described previously.)

f. TRIAL TESTS.

The age of the subjects made it necessary to ensure that the nature of the tests was fully understood by all before the tests proper were applied. For this purpose, special tests—called trial tests—were given on the first morning. Two sets of trial tests were given—S and T Trial Tests. The object of the S tests was to give the subjects the fullest opportunity of becoming familiar with the nature of the tests they were to work later in the main tests; the object of the T tests was to familiarise them with the conditions under which they would be working when the main tests were applied.

Both trial tests consisted of eight slips, each slip containing from three to five examples of any one of the five kinds of tests of which the main tests had been built. Where a test was given in more than one form (as in the case of the Concomitants Test) each form was represented in the trial tests. The following shows the composition of the two trial tests:

- (A) Sentence Completion Test: 5 tests.
- (B) Directions Test: 6 tests (two directions in each sentence).
- (C₁) Concomitants Test. First Form: 4 tests.
- (C₂) Concomitants Test. Second Form: 4 tests.
- (C₃) Concomitants Test. Third Form: 5 tests.
- (D) Analogies Test: 5 tests.
- (E₁) Moral Classifications Test. First Form: 3 tests.
- (E₂) Moral Classifications Test. Second Form: 3 tests.

The S Trial Tests were first given to the subjects.

Each test was worked through separately with the subjects, the test being first carefully explained. The subjects were encouraged to supply answers to the various tests and the suitability of the answers was discussed. In this way it was possible to discover any special difficulties which subjects might be experiencing with any of the tests. The Analogies Test presented greatest difficulties to the subjects, and much of the time given in the trial tests was devoted towards establishing a clear understanding of this test, a large number of illustrative examples being given in addition to those supplied on the Trial Test Sheets.

The T Trial Tests were then given to the subjects. The subjects were told that these tests were similar to the main tests which they were to work later, and that this trial test would provide preliminary practice in order to familiarise them with the conditions under which the main tests would be worked. The subjects were instructed to work as quickly as possible and to turn to the next test sheet immediately on hearing the signal. The trial test was then worked through, the time allowed for each test being regulated by the ease or difficulty it presented to the

subjects. When a large proportion of the subjects appeared to have worked through any particular test sheet, the experimenter gave the signal to turn to the next sheet. When the whole of the T Trial Tests had been worked by the subjects, the experimenter went through the tests with the subjects, discussing the appropriateness of various answers, thus clearing up any outstanding difficulties experienced by the subjects before starting on the main tests.

The first set (X_1) of the tests proper were given about two hours after the trial tests had been worked. The afternoon's tests for the first day (Y_1) were given at an equivalent time in the afternoon.

S

TRIAL TEST B.

Carry out the directions given in the following sentences.

1. Put a cross in the circle .
2. Put a dot above the middle square .
3. Cross out all the i's in this line.
4. Underline the name of a fruit: cat, dog, orange.

S

TRIAL TEST E₂.

In each of the following underline what you consider to be an example of the kind of act printed in heavy type.

Example: A cruel Act: Frequently coming late. Failing to return things borrowed.
Starving a cat.

1. **Courage:** Playing a game of cricket. Horatius defending the bridge. Riding behind a cart.
2. **A Friendly Act:** Coming to school late. Winning a race at the swimming baths. A boy letting his friends have a ride on his bicycle.
3. **A Kind Act:** A landlord not pressing for rent where a father of a family is seriously ill. A carman disappearing with goods entrusted to him. A boy keeping goal well.

T

TRIAL TEST C₁.

Answer the following questions, putting the answer in the space marked

1. What can a parrot do which a fowl cannot do?
2. What is an orange which a lemon is not?
3. What has a broom which a brush has not?
4. What are the Thames and the Severn which the Atlantic and Pacific are not?

T

TRIAL TEST D.

In each of the following supply the fourth word in the way shown in the given examples. The word must make with the third word exactly the same sort of pair as the first two words.

Examples: London : England :: Berlin : Germany
 legs : walking :: tongue : speaking
 clothes : body :: stockings : legs

1 room	: fire	::	the earth	:
2 brass	: polish	::	boots	:
3 furniture	: carpenter	::	house	:
4 dog	: barking	::	lion	:
5 bird	: flying	::	frog	:

Four sample sheets of the S and T Trial Tests are given above.

g. SYSTEM OF MARKING.

Details of the method of scoring adopted for each kind of test will now be given. Marks were deducted for incorrect answers; further, uniformity in the total scores for the different kinds of test was secured by adopting a system of marking which would give an average subject approximately equal scores in the different tests. On this basis, three marks were allotted for a correct answer to a Directions Test, and one mark for a similar answer to a Concomitants Test (third form).

(i) *Sentence Completion Test.* Two marks were awarded for a correct answer. Any word was accepted which made sense, so that a wide range of answers secured the maximum. One mark was given for answers which were less satisfactory and one or two marks were deducted for incorrect answers.

In the shorter leisure test an additional half-mark was given for each correct answer in order to allow for the slightly greater difficulty of this form of the test, as compared with the form in which only one word was omitted.

(ii) *Directions Test.* Two marks were given for a correct answer; one mark was given where the direction was followed except in some unimportant respect; one or two marks were deducted for incorrect answers. In the shorter 'leisure' test, where the difficulty was increased by complication of the expression carrying the direction, three marks were allotted to a correct answer, and two or one for an answer correct in all except some unimportant respect: one, two or three marks were deducted for incorrect answers according to the degree of their incorrectness.

(iii) *Concomitants Test.* For the simplest form of this test—the third form as used in the two 'haste' tests, one mark was awarded for a correct answer and one mark deducted for an incorrect answer. In the second 'leisure' test, where the form was less simple, two marks were given for a correct answer. One mark was deducted where the wrong word was underlined. In the most difficult form of the test, as used in the shorter 'leisure' test, three marks were given for a correct answer. This test, like the Sentence Completion Test, admitted of several answers, all of which were awarded the maximum mark if they provided complete answers. For less satisfactory answers two or one marks were given, and one, two or three marks deducted for incorrect answers.

(iv) *Analogies Test.* Three marks were given for any answer which made a good analogy. One or two marks were given for less satisfactory answers which did not constitute analogies.

(v) *Moral Classifications Test.* In the simpler form, as used in the two 'haste' tests, two marks were given for underlining the correct action, and one mark deducted for incorrect underlining. In the form used for the two 'leisure' tests an additional half-mark was allowed for each correct answer.

h. THE SUBJECTS.

The tests were originally applied to a group of subjects drawn from the Third Year Class of a Council Central (Boys') School. There were 28 subjects in this group, the average age being just over 14 years. The results with this group showed that the tests required modification, particularly in the direction of lengthening the shorter tests.

The tests were accordingly modified in the light of these results, and assumed the form which has already been described. The revised tests were then applied to two other groups, both drawn from classes in the same school. The second group contained 70 subjects, average age 11 years 9 months. The third group contained 60 subjects, average age 13 years.

C. ESTIMATE OF 'SLOWNESS' AND OF INTELLIGENCE.

For each subject in the two groups two estimates were obtained—one of 'slowness' and one of intelligence.

i. 'SLOWNESS.'

Two estimates of this quality were obtained—one estimate was supplied by the class teachers and the other by the manual instructor. In view of the importance of the estimate of 'slowness' care was taken that this estimate should be as accurate as the school conditions would permit. The subjects were kept under observation for some time previous to the estimate being made, their 'slowness' irrespective of their grade of intelligence being constantly noted. The most fruitful soil for such observations was provided by study of the subjects' attitude towards the crop of questions inseparable from school work. Differences in speed in the various school exercises—mathematical problems, composition exercises, geometry, etc.—and attention was also directed to differences in adaptability to change in school tasks. Occasionally specific questions were set to test quickness in apprehension—such as questions demanding alertness in detecting some slight absurdity, inconsistency, etc. The final estimate was influenced by reports of other teachers (language and science teachers) so that the estimate was fairly representative of the subjects' slowness in the general school work. The slowest boy was marked 10, the marks grading down to 1 for the quickest boy.

SAMPLE MARK-SHEET SHOWING METHOD OF TABULATING SCORES.

Individual Tests.

Test	Speed	Test no.	X_1	X_3	X_5	Total $X_1X_3X_5$	X_2	X_4	Total X_2X_4	$X = X_1...X_6$	Test no.	Y_1	Y_3	Total $Y_1Y_3Y_5$	Y_2	Y_4	Total Y_2Y_4	$\bar{Y} = Y_1...Y_5$	
A. Completion	l_1	1	16	18	50	18	18	36	86	1	14	18	18	50	17	16	33	83	
	l_2	20	14	18	48	18	16	34	82	2	14	18	14	46	16	14	30	76	
	h_1	7	8	17	39	14	12	26	65	3	14	18	14	46	20	14	34	80	
	h_2	14	12	14	40	15	16	31	71	4	18	14	14	46	16	16	32	78	
B. Directions	l_1	13	12	24	16	52	18	14	32	84	5	4	15	15	34	9	19	28	62
	l_2	2	12	10	11	33	18	16	34	67	6	20	17	7	44	16	14	30	74
	h_1	10	16	16	19	51	12	18	30	81	7	11	19	16	46	16	18	34	80
	h_2	16	20	19	26	65	20	20	40	105	8	20	19	16	55	20	21	41	96
C. Concomitants	l_1	19	15	12	15	42	16	18	34	76	9	18	18	20	54	179	61	72	133
	l_2	15	11	16	12	39	12	16	28	67	10	12	14	10	56	13	18	31	87
	h_1	3	13	15	14	42	16	18	34	76	11	14	17	9	36	14	11	25	61
	h_2	6	12	15	14	41	14	12	26	67	12	15	15	17	40	12	15	27	72
D. Analogies	l_1	51	58	55	164	58	64	122	286	59	64	56	56	179	52	58	110	289	
	l_2	11	18	13	13	44	18	17	35	79	13	10	18	21	49	18	14	32	81
	h_1	4	15	17	15	47	15	14	29	76	14	17	14	13	44	18	18	36	80
	h_2	17	17	14	11	42	19	14	33	75	15	18	19	18	55	0	17	17	72
E. Moralclassification	l_1	9	13	14	18	45	11	15	26	71	17	9	18	18	45	18	9	27	72
	l_2	12	11	12	11	34	9	17	26	60	18	16	18	15	49	18	15	33	82
	h_1	5	14	12	14	40	10	16	26	66	19	10	19	10	39	4	10	14	53
	h_2	18	10	12	18	40	12	14	26	66	20	16	14	12	42	14	10	24	66
		48	50	61	159	42	62	104	263		51	69	55	175	54	44	98	273	

ii. INTELLIGENCE.

Two estimates of intelligence were supplied by the same teachers. Of the three estimates—perseveration, 'slowness,' intelligence—employed in the present enquiry, the last was the one given with the greatest readiness and confidence. Several school exercises lend themselves particularly well to the formation of an estimate of intelligence—*e.g.* composition, science and, in general, answers to questions testing not so much school-learning as the 'native resources' of the subjects. The general impression formed by repeated examination of such class work was the most important source of the estimates in the present instance; school examinations were not so useful in this connection in view of the fact that such examinations necessarily test much more than intelligence. Observation of the subjects when free from class conditions, as at play, on school excursions, etc., was valuable in amplifying and even correcting the general impression; this observation was most useful in fixing the grade of subjects occupying a middle position in the class scale of intelligence. There was usually no difficulty in identifying subjects occupying the two ends of the scale, the greatest care was required for the exact placing of boys occupying intermediate positions. The marking adopted was as follows: 10 for subjects with best intelligence grading down to 1 for the poorest intelligence.

D. RESULTS.

a. TREATMENT.

a. Tabulation.

The large amount of material yielded by the tests rendered it necessary to tabulate the results in order to facilitate calculation. The scores were tabulated according to two plans: in one table, the arrangement adopted showed the *total* score obtained by a subject in each of the ten series (X_1 to X_5 and Y_1 to Y_5) for all four speeds in the five kinds of tests; the other table showed each subject's *daily* scores in the speed grades of the ten series for all five tests pooled. A sample sheet showing one of the two systems of tabulation is given on previous page.

b. Basic and Derived Correlation Coefficients.

Two sets of correlation coefficients were calculated—a set of 'basic' coefficients calculated directly from the data supplied by the scores and estimates, and a set of 'derived' coefficients obtained from the former by the application of formulae.

(i) '*Basic*' coefficients.

The scores for each of the four speed grades in X and Y (l_1, l_2, h_1, h_2) were correlated with the perseveration tests score and with the estimates

QUICKNESS AND INTELLIGENCE

for 'slowness' and intelligence. These correlations were calculated for each of the five kinds of tests, columns X and Y giving the necessary data.

TABLE D. 'BASIC' CORRELATION COEFFICIENTS. GROUP 3.

Correlations with Perseveration, Intelligence and Slowness.

Correlation with	Individual tests					Daily scores					
	A. Completion	B. Directions	C. Coneomimants	D. Analogies	E. Moral classification	All tests pooled	1st day	2nd day	3rd day	4th day	5th day
1. PERSEVERATION.											
X l_1	102	172	042	037	-056	119	125	-032	027	058	-070
X l_2	046	127	-019	081	-112	086	061	142	-039	039	-032
X h_1	113	117	123	150	151	131	039	-057	110	128	035
X h_2	165	134	-027	043	108	126	067	101	093	141	-057
Y l_1	122	-013	131	021	-067	123	153	064	059	101	067
Y l_2	178	016	-044	138	-034	121	110	169	-020	-005	078
Y h_1	168	069	088	014	152	124	180	089	-063	062	075
Y h_2	027	075	-121	-072	111	081	104	054	107	134	105
2. INTELLIGENCE.											
X l_1	551	417	402	475	340	486	509	425	552	443	502
X l_2	386	424	391	321	465	466	444	447	465	500	358
X h_1	456	356	421	369	614	491	572	428	390	388	566
X h_2	474	473	304	421	460	474	393	478	457	476	456
Y l_1	502	560	505	480	449	505	495	498	417	389	421
Y l_2	540	589	521	518	406	538	461	420	582	531	433
Y h_1	591	531	443	598	419	551	480	475	375	692	427
Y h_2	586	401	333	315	495	496	530	315	364	465	495
3. SLOWNESS.											
X l_1	-305	-390	-310	-293	-400	-304	-309	-280	-398	-431	-345
X l_2	-282	-317	-348	-350	-538	-388	-447	-357	-338	-322	-488
X h_1	-566	-230	-302	-230	-306	-368	-421	-200	-242	-334	-457
X h_2	-233	-360	-312	-307	-388	-353	-362	-285	-346	-336	-437
Y l_1	-311	-463	-558	-292	-298	-398	-343	-325	-346	-302	-284
Y l_2	-369	-428	-407	-306	-286	-412	-387	-378	-461	-335	-253
Y h_1	-268	-260	-231	-316	-322	-276	-308	-308	-289	-363	-198
Y h_2	-582	-237	-240	-233	-391	-302	-290	-306	-344	-249	-357

A similar set of coefficients was calculated for the five daily scores. Table D shows the complete results for both sets, an additional column being interpolated to show the correlations for all five tests pooled.

The intercorrelations among the eight speed grades (l_1, l_2, h_1, h_2 for X and l_1, l_2, h_1, h_2 for Y) were also calculated for each of the five kinds of tests and for each of the five days.

These results are shown in Table E, the correlations for all five tests pooled being also shown.

TABLE E. 'BASIC' CORRELATION COEFFICIENTS. GROUP 3.

Intercorrelations among all Speed-Grades in both X and Y Series.

Correlation between	i. Individual tests				ii. Daily scores						
	A. Completion	B. Directions	C. Concomitants	D. Analogies	E. Moral classification	All tests pooled	1st day	2nd day	3rd day	4th day	5th day
X l_1 & X l_2	854	789	564	810	579	775	825	652	650	668	811
X l_1 X h_1	792	715	470	815	711	730	800	775	684	690	701
X l_1 X h_2	785	717	465	791	694	705	732	634	678	626	741
X l_1 Y l_1	676	733	717	732	413	686	730	688	686	694	681
X l_1 Y l_2	699	693	535	660	474	625	717	600	639	607	710
X l_1 Y h_1	655	661	544	722	565	650	632	734	558	773	628
X l_1 Y h_2	754	512	458	618	515	630	666	636	623	606	611
X l_2 X h_1	753	611	474	782	744	693	807	653	597	664	663
X l_2 X h_2	717	768	533	682	669	715	743	704	619	695	657
X l_2 Y l_1	679	675	420	515	630	628	678	649	578	543	562
X l_2 Y l_2	729	694	680	634	637	654	727	762	578	561	594
X l_2 Y h_1	608	725	527	572	536	620	609	637	590	719	675
X l_2 Y h_2	602	755	561	556	555	610	586	641	596	619	633
X h_1 X h_2	735	716	742	748	639	710	745	692	666	639	812
X h_1 Y l_1	623	579	578	558	742	623	744	610	578	660	580
X h_1 Y l_2	732	531	523	736	533	631	627	679	579	593	760
X h_1 Y h_1	682	678	594	697	670	680	660	738	601	784	588
X h_1 Y h_2	663	667	535	540	734	650	649	703	669	631	672
X h_2 Y l_1	665	653	420	743	731	638	619	610	734	646	631
X h_2 Y l_2	716	697	445	716	695	645	669	662	671	596	589
X h_2 Y h_1	709	711	517	709	638	674	598	672	588	713	667
X h_2 Y h_2	672	680	648	530	613	640	719	660	590	592	660
Y l_1 Y l_2	815	764	667	757	741	740	780	755	706	727	757
Y l_1 Y h_1	755	597	683	732	684	670	725	604	658	756	694
Y l_1 Y h_2	735	652	543	657	667	640	669	629	603	511	668
Y l_2 Y h_1	680	723	565	690	660	673	712	661	542	721	676
Y l_2 Y h_2	640	776	566	724	631	660	617	664	509	669	729
Y h_1 Y h_2	663	739	596	675	708	654	693	664	594	588	642

(ii) 'Derived' Coefficients.

From these basic coefficients a further set was derived by the application of the Spearman formula for correlation of sums and differences:

$$r_{(n_1 a_1 + n_2 a_2 + \dots + n_p a_p)(m_1 b_1 + m_2 b_2 + \dots + m_q b_q)} = \frac{s(nm\sigma_a\sigma_b r_{ab})}{\sqrt{s(n^2\sigma_a^2) + 2s(nn\sigma_a\sigma_a r_{aa})} \sqrt{s(m^2\sigma_b^2) + 2s(mm\sigma_b\sigma_b r_{bb})}}.$$

The formula was exceedingly valuable for this work, being particularly well adapted for the calculation of correlations for the progressive sums and differences desired. As the standard deviations for all the correlations concerned are equalised in the application of the formula, no 'weighting' of the coefficients was necessary. The following details show the method in which the formula was employed:

(a) The 'basic' correlations of perseveration (p), slowness (s) and intelligence I with l_1, l_2, h_1, h_2 for X and Y being known, the correlations of these with the sums $l_1 + l_2$ and $h_1 + h_2$ were required. Denoting $l_1 + l_2$ by L , then

$$r_{pL} = r_{p(l_1+l_2)} = \frac{\sigma_p \sigma_{l_1} r_{l_1 p} + \sigma_p \sigma_{l_2} r_{l_2 p}}{\sqrt{\sigma_p^2 + 0} \sqrt{\sigma_{l_1}^2 + \sigma_{l_2}^2 + 2\sigma_{l_1}\sigma_{l_2}r_{l_1 l_2}}} = \frac{\sigma_{l_1} r_{l_1 p} + \sigma_{l_2} r_{l_2 p}}{\sqrt{\sigma_{l_1}^2 + \sigma_{l_2}^2 + 2\sigma_{l_1}\sigma_{l_2}r_{l_1 l_2}}}.$$

The correlations of p, s and I with L_x, H_x, L_y, H_y were obtained in the same way.

(b) Denoting $l_1 + l_2 + h_1 + h_2$ by X for the X series, and by Y for the Y series, then

$$\begin{aligned} r_{pX} &= r_{p(l_1+l_2+h_1+h_2)} \\ &= \frac{\sigma_{l_1} r_{l_1 p} + \sigma_{l_2} r_{l_2 p} + \sigma_{h_1} r_{h_1 p} + \sigma_{h_2} r_{h_2 p}}{\sqrt{\sigma_{l_1}^2 + \sigma_{l_2}^2 + \sigma_{h_1}^2 + \sigma_{h_2}^2 + 2\sigma_{l_1}\sigma_{l_2}r_{l_1 l_2} + 2\sigma_{l_1}\sigma_{h_1}r_{l_1 h_1} + 2\sigma_{l_2}\sigma_{h_1}r_{l_2 h_1} + 2\sigma_{h_1}\sigma_{h_2}r_{h_1 h_2}}} \text{ etc.} \end{aligned}$$

In a similar manner the correlations of p, s and I were obtained for X and Y.

(c) Denoting by $(L - H)_x$ the difference $L_x - H_x$ or

$$(l_1 + l_2)_x - (h_1 + h_2)_x,$$

then

$$\begin{aligned} r_{p(L-H)_x} &= r_{p(l_1+l_2-h_1-h_2)} \\ &= \frac{\sigma_{l_1} r_{l_1 p} + \sigma_{l_2} r_{l_2 p} - \sigma_{h_1} r_{h_1 p} - \sigma_{h_2} r_{h_2 p}}{\sqrt{\sigma_{l_1}^2 + \sigma_{l_2}^2 + \sigma_{h_1}^2 + \sigma_{h_2}^2 + 2\sigma_{l_1}\sigma_{l_2}r_{l_1 l_2} + 2\sigma_{h_1}\sigma_{h_2}r_{h_1 h_2} - 2\sigma_{l_1}\sigma_{h_1}r_{l_1 h_1} - 2\sigma_{l_1}\sigma_{h_2}r_{l_1 h_2} - 2\sigma_{l_2}\sigma_{h_1}r_{l_2 h_1} - 2\sigma_{l_2}\sigma_{h_2}r_{l_2 h_2}}}. \end{aligned}$$

Thus correlations of p, s and I with $(L - H)_x$ and $(L - H)_y$ are obtained.

(d) Denoting $L_x + L_y$ by L_{x+y} and $H_x + H_y$ by H_{x+y} ,

$$\begin{aligned} r_{pL_{x+y}} &= r_{p(L_x+L_y)} = r_{p(l_{1x}+l_{2x}+h_{1x}, h_{2x})} \\ &= \frac{\sigma_{l_{1x}} r_{l_{1x} p} + \sigma_{l_{2x}} r_{l_{2x} p} + \sigma_{h_{1x}} r_{h_{1x} p} + \sigma_{h_{2x}} r_{h_{2x} p}}{\sqrt{\sigma_{l_{1x}}^2 + \sigma_{l_{2x}}^2 + \sigma_{h_{1x}}^2 + \sigma_{h_{2x}}^2 + 2s(\sigma_{l_{1x}}\sigma_{l_{2x}})}}. \end{aligned}$$

Similarly correlations of p, s and I with L_{x+y} and H_{x+y} were found.

TABLE F. 'DEBIVED' CORRELATION COEFFICIENTS. GROUP 3.

THE MAIN ENQUIRY

Test	Corr. with	L_x	H_x	$(L+H)_x$	$(L-H)_x$	L_{x+y}	H_{x+y}	$Y+X$	$L-H$	$Y-X$	L_y	H_y	$(L+H)_y$	$(L-H)_y$
I. INDIVIDUAL TESTS.														
A. Completion	p	0.79	1.29	1.14	-1.06	1.21	1.48	1.38	-0.55	0.63	1.42	1.34	1.51	0.23
	I	488	496	501	0.53	534	607	589	-1.38	1.51	504	622	628	-218
	s	-302	-412	-389	1.74	-302	-498	-431	308	-1.34	-328	-512	-451	-295
B. Directions	p	1.55	1.09	1.35	0.70	0.87	1.01	-0.51	-1.43	0.05	1.43	0.47	-1.89	
	I	442	459	477	-0.42	552	489	534	1.13	0.78	615	486	569	204
	s	-376	-324	-374	-0.49	-449	-311	-398	-248	0.21	-494	-226	-391	-378
C. Concom.	p	0.10	0.38	0.28	-0.34	0.28	0.23	0.257	0.09	-0.11	0.38	-0.05	0.21	0.49
	I	446	389	471	0.62	538	461	533	1.70	1.45	552	433	531	181
	s	-375	-332	-398	-0.64	-496	-331	-295	-274	-112	-541	-264	-451	-359
D. Analogies	p	0.75	1.32	1.34	-1.30	0.76	0.46	0.64	0.68	-1.42	0.68	-0.50	0.08	189
	I	462	423	463	0.14	518	498	517	0.33	0.86	548	491	544	038
	s	-341	-294	-317	-1.48	-358	-321	-352	-0.75	0.39	-611	0.11	-328	-019
E. Moral class.	p	0.09	1.38	0.32	-0.91	-0.74	1.42	0.48	-0.41	0.40	-0.49	1.34	0.57	-292
	I	470	572	547	-0.243	508	576	554	-0.30	0.21	454	501	506	-261
	s	-549	-395	-207	-0.207	-478	-479	-495	-0.14	1.48	-341	-392	-375	-251
2. DAILY SCORES.														
1st day	p	1.01	0.61	0.84	1.00	1.46	1.13	1.33	0.59	1.64	1.71	1.49	1.67	036
	I	509	509	523	-0.243	542	554	607	-0.47	1.85	521	559	556	-056
	s	-407	-417	-425	-0.38	-423	-382	-417	-0.61	-0.27	-498	-328	-379	-114
2nd ,	p	0.60	0.32	0.49	0.51	0.96	0.58	0.79	0.68	1.16	1.25	0.77	1.06	053
	I	485	497	515	0.66	518	477	516	0.44	0.38	491	436	489	006
	s	-352	-271	-429	-1.84	-388	-302	-366	-107	-1.21	-381	-348	-384	005
3rd ,	p	-0.03	1.11	0.55	1.63	0.11	0.67	0.41	-1.04	-0.59	0.24	0.25	0.04	044
	I	563	470	548	1.93	592	469	532	-2.39	-0.17	535	414	513	145
	s	-374	-324	-370	-1.13	-435	-360	-413	-1.51	-1.48	-434	-349	-423	-095
4th ,	p	0.55	1.50	0.76	-1.39	0.74	1.38	0.97	-1.53	-1.60	0.52	1.06	082	-056
	I	520	483	531	0.63	543	590	512	-0.44	0.58	487	653	608	-104
	s	-417	-340	-401	-1.15	-405	-358	-388	-1.37	-1.11	-335	-333	-366	-228
5th ,	p	-0.05	-0.22	-0.33	-0.51	-0.74	0.19	0.10	-0.76	1.48	0.38	0.67	0.55	-066
	I	444	540	531	-1.29	580	564	541	-1.94	0.15	450	513	556	-017
	s	-403	-456	-469	-0.94	-272	-418	-406	1.22	2.14	-280	-309	-417	-228
3. ALL TESTS POOLED.														
All 5 pooled	p	1.11	1.38	1.31	-0.35	1.48	1.28	1.48	0.41	-0.74	0.71	1.09	091	-066
	I	514	524	531	0.24	556	558	594	0.06	0.83	561	586	556	-017
	s	-378	-382	-391	-0.18	-450	-368	-428	-0.43	-0.30	-283	-316	-417	-228

(e) The progressive application of the formula gave the correlations of p , I and s with the following:

$$Y + X = L_{x+y} + H_{x+y} = (l_1 + l_2)_x + (l_1 + l_2)_y + (h_1 + h_2)_x + (h_1 + h_2)_y.$$

$$(L - H)_{x+y} = L_{x+y} - H_{x+y} = (l_1 + l_2)_x + (l_1 + l_2)_y - (h_1 + h_2)_x - (h_1 + h_2)_y.$$

$$\begin{aligned} Y - X &= (L + H)_y - (L + H)_x = \\ &\quad (l_1 + l_2 + h_1 + h_2)_y - (l_1 + l_2 + h_1 + h_2)_x. \end{aligned}$$

A complete set of the above 'derived' coefficients was calculated for (a) each of the five kinds of tests, (b) each of the five days, (c) for all five tests pooled. This systematic calculation of both 'basic' and 'derived' coefficients was carried out completely only in the case of the third group; the calculation with the second group, while not so complete, suggested the methodic system applied to the third group. The full results for the 'derived' coefficients for the third group are set out in Table F.

It may be of interest to note here the number of correlation coefficients calculated in accordance with the foregoing description. For Group 3 572 'basic' and 429 'derived' coefficients were calculated, a total of 1001 coefficients; for Group 2 over 500 coefficients were calculated; finally, about 200 other coefficients were calculated in the course of the present enquiry—a total in all of about 1700 coefficients.

b. CONSIDERATION OF RESULTS.

(A)

1. Reliability of the Tests.

Since the correct estimation of the results obtained in this enquiry is dependent upon a knowledge of the reliability of the tests employed, consideration will first be given to reliability. As will have been noted from the description of the tests previously given, each boy worked through 200 separate test sheets. The numbers of the five kinds of tests which appeared on these sheets were as follows: 440 Sentence Completions, 450 Directions, 590 Concomitants, 360 Analogies and 410 Moral Classifications—a total of 2250 tests. Each kind of test appeared four times in any one series (X or Y), so that in the whole ten sessions in which the application took place, each kind of test was submitted to 40 repetitions. So large a number of repetitions must exercise an important effect on the reliability. Variations in performances due to chance errors, fatigue, changes in attitude, etc., will tend to be eliminated in the course of these repetitions. The thorough repetition, together with the abundance of

material employed in the tests, would therefore be expected to produce high reliability.

The reliability coefficients actually obtained are given in Table I.

TABLE I. RELIABILITY COEFFICIENTS.

	Completion	Directions	Con-comitants	Analogies	Moral class.	All tests pooled	
GROUP 3.							
X l_1	611 054	561 060	595 055	691 045	531 062	642 050	
X l_2	638 050	748 037	531 062	648 049	594 056	715 041	
X h_1	614 054	667 047	647 049	651 049	693 045	742 038	
X h_2	646 049	636 050	515 064	592 056	571 059	622 053	
Y l_1	688 045	656 048	512 064	601 055	513 064	716 041	
Y l_2	694 045	638 050	624 053	594 056	856 021	804 029	
Y h_1	807 028	655 049	795 029	712 042	672 047	801 029	
Y h_2	622 053	625 052	610 054	564 060	623 053	701 043	
Average	665 047	648 049	604 055	632 052	632 052	718 041	Average = 682 046
GROUP 2.							
X l_1	645 047	604 053	621 051	668 045	588 053	671 045	
X l_2	626 050	686 043	573 056	694 043	621 051	689 043	
X h_1	641 048	731 037	701 041	648 047	687 043	727 037	
X h_2	634 050	642 048	565 056	631 050	605 052	638 048	
Y l_1	669 045	631 050	571 056	589 053	579 055	629 050	
Y l_2	737 036	662 046	614 052	636 048	717 039	742 036	
Y h_1	784 031	635 048	743 036	721 039	664 046	778 031	
Y h_2	651 047	641 048	636 048	611 052	648 047	668 045	
Average	673 043	654 047	628 050	649 047	639 048	693 041	Average = 681 044

The coefficients were calculated for each of the five kinds of tests, in each case for the eight forms (Speeds) in which the test appeared, *i.e.* four for X (l_1, l_2, h_1, h_2) and four for Y (l_1, l_2, h_1, h_2).

The method of calculation in each case was to correlate the pooled score for the first, third and fifth days with the pooled score for the second and fourth days. The grouping of alternate days has a distinct advantage over the grouping of successive days; for in the latter method, any regular error appearing in the daily performances is likely to be accentuated in taking together say the first three days and last two days, whereas the random character of the grouping is emphasised in selecting 'odd' days for correlation with 'even' days. By reference to Table I it will be noted that each test shows a fairly high average reliability in both Groups 2 and 3. The slightly lower value of the reliability in the case of the Concomitants Test may be due to the fact that this test was the least homogeneous of all five tests. Higher reliability coefficients are to be expected in the case of 'derived' coefficients obtained by pooling the elements represented in Table I, since chance differences disappear in the mutual cancellation of random errors which is effected when pooling takes place. It will be noted that the Y tests show a rather higher average reliability than the X tests; the explanation is perhaps to be found in the more favourable arrangement of the Y series. Further, the intermediate lengths, l_2, h_1 , possess slightly higher reliabilities than the extreme lengths l_1, h_2 , in both X and Y series, a point which will be considered again in relation to the comparative values of the various lengths of tests employed in this enquiry.

2. *Reliability of the Estimates.*

(a) *Intelligence.* The estimate of intelligence was made by two observers: in both groups the two independent estimates correlated very highly, the correlation for Group 2 being .81 and for Group 3 .84. The conditions for forming such estimates are very favourable in the case of teachers: the class-work affords daily opportunities for testing intelligence, and observation is always possible for the purpose of checking or modifying the estimate. The reliability is likely to become unduly high when constant interchange of opinion passes between the teachers giving the estimate. This fact came out prominently in an enquiry conducted by Waite concerning the reliability of teachers' estimates¹. Waite's results gave a low value to the reliability (.49) when the conditions were arranged so that the estimates were as independent as

¹ *Biometrika*, 8, p. 79.

possible. While it is impossible to prevent entirely any interchange of opinion and so secure two perfectly independent estimates—a fair degree of independence can be attained by arranging that the estimates shall be given by teachers engaged in dissimilar capacities with the pupils. In the present enquiry, for instance, the estimates were formed by the teacher engaged in general class-work, and by the manual instructor, whose work is of a totally different character from that of the class teacher.

(b) *Slowness.* The reliability of estimate of 'slowness' was low in each group, being .42 for Group 2 and .55 for Group 3. The low value was due in great measure to the difficulty of separating, in practice, speed and intelligence. As in the case of the perseveration estimate, the teacher's interpretation of what was required exercised a profound influence on the forming of the estimates: in fact, far more was left to the judgment of the teacher than was the case with the intelligence estimate, for in the latter case the concrete work of the subjects was constantly receiving the attention of the teacher. The reliabilities, though low, indicate that a very fair degree of agreement was reached by the teachers in their estimation of slowness. The higher reliability in the third group was due no doubt to the fact that the subjects in this group were older than those in the second group, and were therefore better known to the teachers, having been at least a year longer at the school than the subjects in the second group.

(B) Correlations: 'derived' coefficients.

1. *Correlations with $Y + X$.*

Turning now to the 'derived' coefficients, the correlations with $Y + X$ will be considered. Tables II and III show the correlations of $Y + X$ with estimate of intelligence (I), perseveration score (P) and estimate of slowness (s) for each of the five tests, and for all tests pooled. The most significant feature in both tables is the high correlation with the estimate of intelligence, almost .6 in Group 3 and .67 in Group 2 for all tests pooled. Since $Y + X$ is the total score in the whole of the tests, it may well be regarded as a measure of intelligence. The high correlation with the estimate of intelligence is thus an index of the reliability of this estimate. In a similar way the negative correlation of $Y + X$ with the estimate of slowness imparts a certain amount of confidence to this estimate. The pooled tests show a correlation of about $- .4$ with 'slowness': a far larger negative value would have been expected if the estimate of 'slowness' had been based purely on the

judgment of the intelligence of the subjects. The correlation -0.4 is large enough to indicate an admixture of intelligence considerations in the estimate of 'slowness' and yet small enough to permit of factors, other than intelligence, exercising an influence on the estimate. Finally, the correlation of $Y + X$ with perseveration is positive in all tests except one; this would appear to indicate that the perseveration tests were not entirely free from the influence of ' g ' (the general common factor); the correlations, however, are not high enough to detract from the value of the perseveration score as a measure of perseveration. Consideration of the results for $Y + X$ thus tends to strengthen the claim of the estimate of intelligence and of 'slowness' and the perseveration score to be used as measures of these qualities in this enquiry.

TABLE II. CORRELATIONS WITH $Y + X$.

	Completion	Directions	Con-comitants	Analogies	Moral classification	All tests pooled
GROUP 3.						
<i>I</i>	589 056	534 062	533 062	517 064	554 061	594 056
<i>p</i>	138 086	101 087	025 088	064 088	048 088	148 086
<i>s</i>	-431 071	-398 074	-295 080	-352 077	-495 066	-428 071
GROUP 2.						
<i>I</i>	591 051	653 045	629 048	614 050	651 045	671 043
<i>p</i>	213 076	117 079	008 080	056 080	-036 080	107 079
<i>s</i>	-430 065	-303 072	-380 068	-378 068	-396 067	-440 064

2. 'Leisure' and 'Haste' Tests.

Table III gives the correlations for a lower degree of pooling, namely L_x , L_y , H_x , H_y , where $L_x = l_{1x} + l_{2x}$ and $H_x = h_{1x} + h_{2x}$. These results are of interest in connection with an important question affecting the use of tests. Current practice favours the giving of a large number of short tests in a short period of time: it has been questioned, however, whether better results would not be secured by giving fewer tests of greater length with a larger time allowance. A consideration of the results with 'leisure' and 'haste' tests, as set out in Table III, will be of service in deciding as to the relative merits of long and short tests for practical purposes.

These results give no clear indication that subjects do better in the 'leisure' tests than in the 'haste' tests.

TABLE III. CORRELATIONS WITH L_x , H_x , L_y , H_y . GROUP 3.

	Completion		Directions		Concomitants		Analogies		Moral classification		All tests pooled	
	L_x	L_y	L_x	L_y	L_x	L_y	L_x	L_y	* L_x	L_y	L_x	L_y
<i>I</i>	485 066	504 065	442 070	615 054	446 069	552 061	462 068	548 061	470 068	454 069	514 064	561 060
<i>p</i>	079 088	142 086	155 086	005 088	010 088	038 088	075 088	068 088	009 088	-049 088	111 087	071 088
<i>s</i>	-302 080	-328 079	-376 076	-494 066	-375 076	-541 062	-341 078	-611 054	-549 061	-341 078	-378 076	-316 079
	H_x	H_y	H_x	H_y	H_x	H_y	H_x	H_y	H_x	H_y	H_x	H_y
<i>I</i>	496 065	622 053	459 068	486 066	389 075	433 071	423 072	491 066	572 059	501 065	524 064	586 056
<i>p</i>	129 087	135 087	109 087	143 086	038 088	-005 088	132 087	050 088	138 086	134 087	138 086	109 087
<i>s</i>	-412 072	-512 064	-324 079	-226 083	-332 079	-264 082	-294 081	011 088	-395 075	-392 075	-382 076	-316 079

This is brought out more clearly in Table IV below, in which all 'leisure' tests in (X and Y) are pooled and similarly with the 'haste' tests. Since neither 'haste' nor 'leisure' tests possess any clear advantage over the other, the use of a large number of short tests may serve equally well with the practice of giving longer and more elaborate tests with a liberal time allowance.

TABLE IV. CORRELATIONS WITH L_{x+y} AND H_{x+y} . GROUP 3.

	Completion		Directions		Concomitants		Analogies		Moral classification		All tests pooled	
	L_{x+y}	H_{x+y}	L_{x+y}	H_{x+y}	L_{x+y}	H_{x+y}	L_{x+y}	H_{x+y}	L_{x+y}	H_{x+y}	L_{x+y}	H_{x+y}
<i>I</i>	534 064	607 054	552 061	489 066	538 062	461 068	518 064	498 065	508 064	576 058	556 060	558 060
<i>p</i>	121 087	148 086	087 088	101 087	028 088	023 088	076 088	046 088	-074 088	142 086	148 086	128 087
<i>s</i>	-302 080	-498 065	-449 066	-311 080	-496 065	-331 079	-358 077	-321 079	-478 067	-474 068	-450 069	-368 076

The conclusion just reached derives support from a consideration of the correlations between L and H. In Table V overleaf are set forth

the intercorrelation between l_1 , l_2 , h_1 and h_2 for all five tests pooled in Group 3. The table is divided into four compartments, A , B , C and D . A contains all the intercorrelations between l_1 and l_2 ; C all those between h_1 and h_2 ; and B and D all those between l and h . The average intercorrelations for each compartment are shown in the two small tables.

TABLE V. INTERCORRELATIONS BETWEEN l_1 , l_2 , h_1 , h_2 (X AND Y).

GROUP 3.

	X l_1	X l_2	Y l_1	Y l_2	X h_1	X h_2	Y h_1	Y h_2
X l_1	—	.78 033	.69 045	.63 052	.73 039	.71 042	.65 049	.63 052
X l_2	.78 033	—	.63 052	.65 049	.79 031	.72 041	.62 053	.61 054
Y l_1	.69 045	.63 052	—	.74 038	.62 053	.64 050	.67 047	.64 050
Y l_2	.63 052	.65 049	.74 038	—	.63 052	.65 049	.67 047	.66 048
X h_1	.73 039	.69 045	.62 053	.63 052	—	.71 042	.68 046	.65 049
X h_2	.71 042	.72 041	.64 050	.65 049	.71 042	—	.67 047	.64 050
Y h_1	.65 049	.62 052	.67 047	.67 047	.68 046	.67 047	—	.65 049
Y h_2	.63 052	.61 054	.64 050	.66 048	.65 049	.64 050	.65 049	—

*C**D*

Average Intercorrelation.

GROUP 3

A *B*

.69 045	.66 048
.66 048	.67 047

C *D*

GROUP 2

A *B*

.71 038	.73 035
.73 035	.69 041

C *D*

For Group 3 the average intercorrelation between the 'leisure' tests is .69; between the 'haste' tests .67 and between the 'leisure' and 'haste' tests .66. Thus the 'leisure' and 'haste' tests correlate with one another to the same extent as both the 'leisure' and 'haste' tests intercorrelate among themselves. A similar result is obtained for Group 2. In this

group, both 'leisure' tests have been pooled to give L and both 'haste' tests to give H. The average correlations for the L and the H tests are .71 and .69 respectively, and the inter-correlations between the L and H tests have an average value of .73.

While no clear advantage can therefore be claimed by either the 'leisure' tests or the 'haste' tests, a more detailed examination of the results shows that an intermediate length of test seems to be the most desirable. Table VI gives the correlations with intelligence for the four lengths of tests used in X and Y in the two groups. No particular length

TABLE VI. CORRELATION OF INTELLIGENCE WITH EACH SPEED
(l_1, l_2, h_1, h_2).

GROUP 3

GROUP 2

X series				Y series				Test	X series				Y series			
l_1	l_2	h_1	h_2	l_1	l_2	h_1	h_2		l_1	l_2	h_1	h_2	l_1	l_2	h_1	h_2
551 061	386 075	456 068	474 068	502 068	540 062	571 059	536 062	Completion	530 056	482 061	498 059	546 055	510 058	570 053	484 061	516 058
417 072	424 072	356 077	473 068	560 060	589 056	531 062	401 074	Directions	540 056	497 059	510 058	530 056	606 050	640 046	582 052	562 054
402 074	396 074	324 079	304 080	505 065	521 064	443 070	333 079	Concomi- tants	510 058	574 053	588 050	502 059	485 060	604 051	634 048	587 050
475 067	321 079	369 076	421 072	480 067	518 064	598 055	315 079	Analogies	567 059	632 048	633 048	583 052	559 054	680 042	583 052	542 056
340 078	465 068	614 054	460 068	449 069	406 072	419 072	495 065	Moral class.	527 056	597 051	624 049	606 050	660 044	564 054	598 051	648 045
437 070	398 074	424 072	426 071	479 068	515 064	513 064	416 072	Average	535 056	556 054	567 053	553 055	564 054	611 050	576 052	571 053

stands out more markedly than the others in each group: it will be noted however, that in both groups the third length, h_1 , has the highest average when X and Y are pooled, so that an intermediate length appears to be the most satisfactory. Earlier in this section, attention was called to the higher reliability shown by the two intermediate lengths; this higher reliability, together with the higher correlation with intelligence, places the third length in the most favourable position as compared with the other three lengths.

3. Correlations with L - H.

Consideration will now be given to those of the 'derived' coefficients which have the greatest significance for the main problem with which the enquiry is concerned. The 'derived' coefficients which may be

expected to throw most light on the nature of 'slowness' are those with $L - H$ and $Y - X$. As was noted earlier, no 'weighting' by reason of unequal standard deviation was necessary in calculating the 'derived' coefficients, since all the correlation coefficients involved were reduced to equal standard deviation in the application of the Spearman formula for sums and differences.

Since slow subjects will tend to do relatively better in the 'leisure' than in the 'haste' tests, the difference ($L - H$) between their performances in these two kinds of tests may be regarded as a measure of 'slowness.' In Tables VII, VIII and IX are set out the correlation of $L - H$ with estimate of intelligence, perseveration and estimate of 'slowness.' Table VII gives these correlations for the individual tests with all X tests pooled, and also the same correlations with all Y tests pooled; in Table VIII both X and Y, are pooled; while the results for final pooling of all the tests for X, for Y, and for $X + Y$ are given in Table IX. Taking these pooled results first (Table IX) it will be noted that there is practically no correlation with perseveration in either Group 2 or Group 3. This would tend to show that perseveration is not an appreciable factor in 'slowness.' A similar result was found in the observations described earlier; perseveration was there noted to form only one of several factors tending to produce 'slowness' in the subjects under observation.

Of greater significance is the very low correlation of $L - H$ with the estimate of 'slowness.' The low correlation of $L - H$ as a measure of 'slowness' with the estimate of the same quality is altogether inconsistent with the existence of a general speed ability. Reasons were adduced earlier in this section for the belief that while the estimate of 'slowness' was influenced by considerations of the intelligence of the subjects observed, there was still considerable room for the play of other factors. An important factor, which, one may be certain, guided the observer in forming the estimate of 'slowness' was a belief in the existence of a general speed ability. Indeed, the instructions given to the observer would allow such a belief full play, since he was asked to divorce 'slowness' from intelligence in arriving at his estimate of the former, and the deprivation of the powerful criterion supplied by intelligence would compel the observer to lean all the more on any opinion he might entertain as to the existence of a general speed ability. Added strength is thus given to the conclusion that the low correlation of $L - H$ with the estimate renders untenable the hypothesis of a general speed ability.

The slight differences which appear among the correlations of

$L - H$ for the individual tests (Table VII) are smoothed down in the pooled results just described. In the main, however, the results for the individual tests point to the same conclusion as was reached in the

TABLE VII. CORRELATIONS WITH $L - H$.

GROUP 3

GROUP 2

	Completion	Directions	Concomitants	Analogies	Moral classification		Completion	Directions	Concomitants	Analogies	Moral classification	
$(L - H)_x$												
<i>I</i>	053 088	-042 088	062 088	014 088	-243 083		<i>I</i>	-130 079	-357 067	048 080	097 080	-143 079
<i>p</i>	-106 087	070 088	-034 078	-130 087	-391 075		<i>p</i>	-040 080	-084 080	-113 079	-138 079	022 080
<i>s</i>	174 086	-049 088	-054 088	-148 087	-207 084		<i>s</i>	-050 080	146 078	-152 078	-217 076	043 080
$(L - H)_y$												
<i>I</i>	-218 084	204 084	181 085	038 088	-261 082		<i>I</i>	-025 080	176 077	-230 075	-195 077	-338 070
<i>p</i>	023 088	-189 085	049 088	189 085	-292 081		<i>p</i>	025 080	097 080	085 080	047 080	-295 072
<i>s</i>	-295 080	-378 076	-359 077	-019 088	251 083		<i>s</i>	014 080	029 080	-144 078	-186 077	212 076

TABLE VIII. CORRELATIONS WITH $L - H$ ($X + Y$ POOLED).

GROUP 3

GROUP 2

	Completion	Directions	Concomitants	Analogies	Moral classification		Completion	Directions	Concomitants	Analogies	Moral classification	
<i>I</i>												
<i>I</i>	-138 086	113 087	170 086	033 088	-301 080		<i>I</i>	-094 080	-103 079	-099 079	095 079	-396 068
<i>p</i>	-055 088	-051 088	009 088	068 088	-401 074		<i>p</i>	-017 080	006 080	029 080	-104 079	181 077
<i>s</i>	308 080	-248 083	-274 082	-075 088	164 086		<i>s</i>	-022 080	188 077	-187 077	-416 068	251 075

consideration of the pooled results. The correlations with perseveration are all very low or negative, and in the pooled results they become almost negligible. All the correlations are negative in the case of 'slowness'

QUICKNESS AND INTELLIGENCE

for Group 3 with two exceptions, and are very low in Group 2; in the pooled results in each group the correlations are again very small.

TABLE IX. CORRELATIONS WITH $L - H$ (ALL TESTS POOLED).

	GROUP 3			GROUP 2			
	$(L - H)_x$	$(L - H)_y$	$(L - H)_{x+y}$		$(L - H)_x$	$(L - H)_y$	$(L - H)_{x+y}$
<i>I</i>	024	-017	006	<i>I</i>	-018	-093	-072
	088	088	088		080	079	080
<i>p</i>	-035	-066	041	<i>p</i>	-112	068	-099
	088	088	088		079	080	079
<i>s</i>	018	-228	-043	<i>s</i>	-015	108	193
	088	083	088		080	079	079

4. Correlations with $Y - X$.

The correlations of $Y - X$ with the estimate of intelligence, etc., as set out in Table X, will now be considered. The 'mixed' arrangement

TABLE X. CORRELATIONS WITH $Y - X$.

	GROUP 3					
	Completion	Directions	Concom.	Analogies	Moral class.	All tests pooled
<i>I</i>	151	078	145	086	021	083
	086	088	086	088	088	088
<i>p</i>	063	-143	-011	-142	049	-074
	088	086	088	086	088	088
<i>s</i>	-134	021	-112	039	148	-030
	087	088	087	088	086	088

GROUP 2

	Completion	Directions	Concom.	Analogies	Moral class.	All tests pooled
<i>I</i>	-087	-188	-199	-134	-007	-163
	079	077	077	079	080	078
<i>p</i>	107	-282	-026	-059	-067	112
	079	073	080	080	080	079
<i>s</i>	168	032	074	047	-037	-083
	078	080	080	080	080	080

of the tests in the X series called for rapid changes in adjustment on the part of the subject and thus tended to penalise those of the perseverating type. The orderly arrangement of the tests in the Y series was more

favourable to this type of subject, as no such rapid changes were involved. Hence $Y - X$ may be taken as a measure of perseveration. The above table shows that $Y - X$ has an extremely small correlation with 'slowness'; this would tend to confirm the conclusion previously arrived at, that perseveration is not a main factor in producing 'slowness.'

From the same table, however, it will be seen that $Y - X$ has practically no correlation with perseveration. Some doubt is thus thrown on the validity of either $Y - X$ or the perseveration score as a measure of perseveration. There is no reason to question the value of the perseveration score in this connection, as has already been pointed out in the section on perseveration: the score is derived from tests having an appreciable positive correlation with one another; the tests correlate with the estimate of perseveration, and have the additional advantage of agreeing with the results obtained by Lankes and by Jones in their work on perseveration. A further argument against the use of $Y - X$ as a measure of perseveration is to be found in the very low reliability: this reliability had the value of .148 for the second group. With this low reliability, the correction necessary for all correlation coefficients is so large as to make all these coefficients valueless for the purpose of discussion. It should be added that the reliability of $L - H$ had a much higher value (.48) in the group for which it was calculated. This reliability was not too low to vitiate the coefficients by the necessity of a large correction.

5. *The Effect of Practice.*

Nothing has been said so far concerning the coefficients calculated on the basis of each day's score. These results afford interesting information as to the effect of practice. Hitherto little agreement has prevailed on the subject of the effect of practice on correlation. Burt¹ found that the effect of practice was to diminish the correlations; Abelson², on the other hand, found that a slight increase was produced with practice; while Thorndike's³ results showed that an improvement was to be noted only in the case of the best subjects.

The tests employed in the present enquiry provided the most favourable means for giving the fullest play to the practice effect: not only were tests repeated in any one session, but the repetition was maintained from day to day. In spite of the very thorough practice provided, no practice

¹ Burt, "Exper. Tests of Gen. Intell." *Brit. Journ. of Psych.* **3**, p. 94.

² Abelson, "Meas. of Mental Ability in Backward Children," *Ibid.* **4**, p. 159.

³ Thorndike, "Notes on Practice and Improvability," *Amer. Journ. of Psych.* 1915, **27**, p. 550.

effect is clearly marked in the correlations with intelligence as set out in Table XI: indeed the most striking feature of the table is that none of the various correlations with intelligence show a tendency to increase. This result is of interest in connection with the problem of 'coaching' for tests. A very serious obstacle to the widespread application of tests for examination purposes is that special training in working out tests may entirely nullify their value for selection purposes. Evidence is here supplied that such training will not affect the value of the tests in so drastic a manner, for the subjects in this enquiry were unable, under the most favourable conditions of repetition, to effect an appreciable improvement in their performances.

TABLE XI. EFFECT OF PRACTICE ON CORRELATION
WITH INTELLIGENCE. GROUP 3.

Speed	1st day	2nd day	3rd day	4th day	5th day
X l_1	509 064	425 071	552 061	443 070	502 065
X l_2	444 070	447 069	465 068	500 065	358 077
X h_1	572 059	428 071	390 075	388 075	566 059
X h_2	393 075	478 067	457 068	476 067	456 068
Y l_1	495 065	498 065	417 072	389 075	421 072
Y l_2	461 068	420 072	582 058	531 062	433 071
Y h_1	480 067	475 067	375 076	692 045	427 071
Y h_2	530 062	315 079	364 077	465 068	495 065

c. GENERAL RESULTS.

The principal conclusions reached in the foregoing discussion may now be briefly re-stated. With regard to the main problem with which the enquiry is concerned—namely that of the existence of a speed ability—it may be fairly claimed that the method adopted was adequate for the investigation of this problem. The principle of 'leisure' and 'haste' tests allowed full play for the exercise of the hypothetical speed ability. The results, however, showed no clear evidence of the existence of this ability. The 'crucial' correlation of $L - H$ with estimate of 'slowness' was

negligible, and even with allowance made for the necessarily approximate nature of the estimate, the result was far from encouraging any belief in the existence of a speed ability. When the thoroughness of the method is recalled, each test being repeated 40 times in the course of the application, a fair degree of confidence may be placed in the result. In the absence, therefore, of a general speed factor, one must refer the 'slowness' exhibited by subjects to such causes as have been described in the section dealing with the class observations. The results showed, too, that perseveration is not a general cause of 'slowness,' although, like the other factors, it may be effective in individual cases.

On the basis of the results obtained in the enquiry no clear decision is possible as to the relative merits of long and short tests. Neither kind of test, however, displayed any marked advantage over the other. In conjunction with the previous results, one may conclude that, while the objection advanced against the use of a large number of short tests has been shown in this enquiry to possess no validity, the use of a smaller number of more elaborate tests can be resorted to with equal safety.

Finally, no marked increase in the correlation with intelligence was observable in the results for each day. The large number of repetitions of tests entailed by the method employed afforded a very favourable opportunity of observing the effects of practice. The negative results obtained would appear to indicate that practice does not materially affect a subject's performance in any set of tests, so that the objection as to the possibility of 'coaching' is not well grounded.



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